AMERICAN ENGINEER AND RAILROAD JOURNAL.

NOVEMBER, 1899.

CONTENTS.

TEN-WHEEL PASSENGER LOCOMOTIVES.

Lake Shore & Michigan Southern Ry.
Built by the Brooks Locomotive Works.

Mr. W. H. Marshall, Superintendent of Motive Power.

Through the courtesy of Mr. W. H. Marshall, Superintendent of Motive Power of the Lake Shore, and the Brooks Locomotive Works, the accompanying engravings of one of eleven new 10-wheel passenger locomotives for that road are published.

These are very powerful locomotives, and are the heaviest in this class of service, with the exception of the Schenectady 10-wheel compounds built in 1897 for the Northern Pacific. They have more heating surface than any other passenger engines of which we have record. With 20 by 28 inch cylinders, 210 pounds steam pressure and 80-inch driving wheels, they ought to be able to do the work expected of them with ease. These engines are about 25 per cent. stronger in tractive power (about 25,000 lbs. tractive power) than any passenger engines now on the road, and they have about 60 per cent. more boiler power based on the heating surface, as well as a greater power based on grate area. They are not designed to make phenomenal speeds, but simply to haul the heaviest trains at their present schedules, and have enough reserve power to make up time when there is any occasion to do so. The present passenger engines will handle about 12 cars as a maximum on schedules of slightly more than 40 miles per hour, the new ones are expected to be able to haul 14 cars at 60 miles per hour when occasion requires, and the same number at the schedule speeds with a margin of power to spare. An eight-wheel engine cannot be expected to do this. The trains sometimes have more than 12 cars, and it has been necessary to run them in two sections.

The 10-wheel type was selected because it permits of putting more weight into the boiler than is permissible with the eight-wheel type or a mogul, on the assumption that the upper limit of total weight is not specified.

The boiler is large. It is of the extended wagon top, radial stay type, with the firebox over the frames. The diameter of the front end of the shell is 66 inches, and at the throat 74 inches. There is ample room at the back ends of the tubes for water space and circulation, the boiler being unusually wide at the throat. The height of the center of the boiler above the rails is 9 ft. 2 in. The large heating surface, 2917 sq. ft., has already received comment. Fifteen feet as the length of tubes is rather unusual, but this was exceeded by the Baldwin Atlantic type passenger engines for the Burlington (American Engineer, May, 1899), which have tubes 16 ft. long. It is believed that increasing lengths of tubes will probably be a feature of future designs. Butt joints are used on all the horizontal boiler seams. Mr. Marshall believes in following theoretically correct practice in this regard, as a result of experience which shows that trouble usually results when theory is departed from in boiler construction.

Among the details several good features are noticed, such as enlarged cross-head fits for the piston rods, extended piston rods, enlarged wheel fits for the crank pins and axles, large (9 by 12-inch) driving journals, and 6 by 12-inch engine truck journals. Cast steel is used to an unusual extent to save weight. The equalizers and fulcrums in connection with the under-hung spring rigging are of this material. The saving of unnecessary weight has been studied with great care. The valves have Allen ports, and are provided with the Richardson balance. The link radius is short. The brake shoes are placed back of the driving wheels, giving an upward thrust to the hangers when the brakes are applied.

The large driving wheels necessitated a long wheel base, the driving wheel base being 16 ft. 6 in., the engine as a whole being 41 ft. 4½ in. long. The cab has a full deck, making a comfortable arrangement for the men. The tender journals are larger than usual for a 5,000 gallon tank, being 5½ by 10 inches. The reason for using this heavy axle is that the largest size previously used on this road was 4¼ by 8 inches, and it was necessary to increase this for these tenders. In making them larger, provision was made for trucks which should be strong enough for the heaviest tender that will be required, which was wise. This road has already planned tenders for 6,000 gallons and 12 tons of coal for freight engines, and these trucks are to be interchangeable in every respect between passenger and freight service.

This design is characteristic of Mr. Marshall's work. It includes no novelties or radical departures, but embodies careful balancing of the factors which go to make up a powerful locomotive with a minimum of unproductive weight. The engines are exceedingly well proportioned and very handsome.

Description.

Gauge	4 ft. 8½ in.
Kind of fuel to be used	Bituminous coal
Weight on drivers	133,000 lbs.
Weight on trucks	38,600 lbs.
Weight, total	171,800 lbs.
Weight, tender loaded	112,000 lbs.

General Dimensions.

Wheel base, total of engine	27 ft. 4 in.
Wheel base, driving	16 ft. 6 in.
Wheel base, total, engine and tender	55 ft. 2¼ in.
Length over all, engine	41 ft. 4½ in.
Length over all, total, engine and tender	64 ft. 4¾ in.
Height, center of boiler above rails	9 ft. 2 in.
Height of stack above rails	14 ft. 11 in.
Heating surface, firebox and arch flues	223 sq. ft.
Heating surface, tubes	2,694 sq. ft.
Heating surface, total	2,917 sq. ft.
Grate area	33.6 sq. ft.

Wheels and Journals.

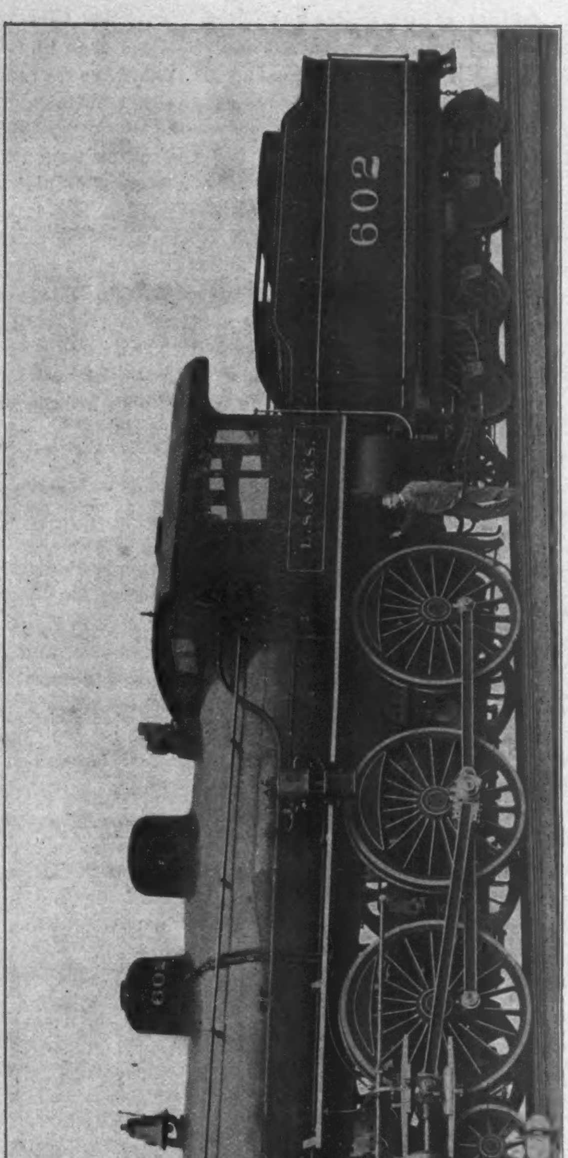
Drivers, diameter	80 in.
Drivers, material of centres	Cast steel
Truck wheels, diameter	36 in.
Journals, driving axle	9 in. by 12 in.
Journals, truck axle	6 in. by 12 in.
Main crank pin, size	6½ in. by 6 in.
Main coupling pin, size	7¼ in. by 4½ in.
Main pin, diameter wheel fit	7⅝ in.

Cylinders.

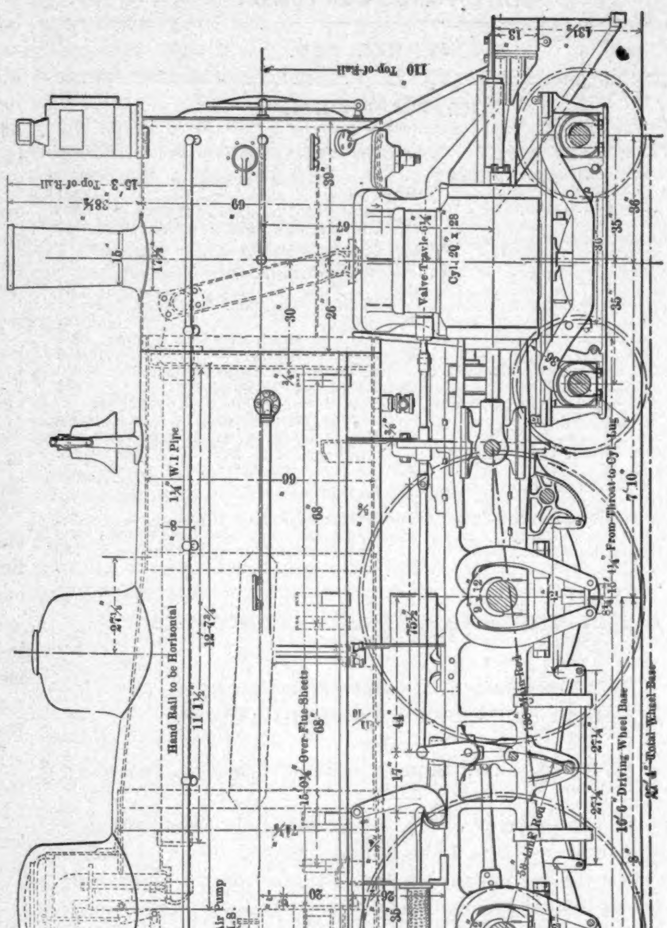
Cylinders, diameter	20 in.
Piston, stroke	28 in.
Piston rod, diameter	3⅝ in.
Main rod, length, centre to center	138 in.
Steam ports, length	19 in.
Steam ports, width	1⅝ in.
Exhaust ports, length	19 in.
Exhaust ports, width	2¾ in.
Bridge, width	1⅝ in.

Valves.

Valves, kind of	Allen-Richardson balanced
Valves, greatest travel	6.2 in.
Valves, outside lap	1⅛ in.
Valves, inside clearance	⅛ in.
Lead in full gear	1/16 in. negative



Powerful 10-Wheel Passenger Locomotive—Lake Shore & Michigan Southern Ry.



Powerful 10-Wheel Passenger Locomotive—Lake Shore & Michigan Southern Ry.

W. H. MARSHALL, *Superintendent Motive Power.* BROOKS LOCOMOTIVE WORKS, *Builders.*

Boiler.

Boiler, type of....................Extended wagon top
Boiler, working steam pressure....................210 lbs.
Boiler, material in barrel....................Steel
Boiler, thickness of material in barrel..........⅝ in., 11/16 in., ¾ in.
Boiler, thickness of tube sheet....................¾ in.
Boiler, diameter of barrel, front....................66 in.
Boiler, diameter of barrel at throat....................74⅞ in.
Crown sheet, stayed with....................Radial stays
Dome, diameter....................30 in.

Firebox.

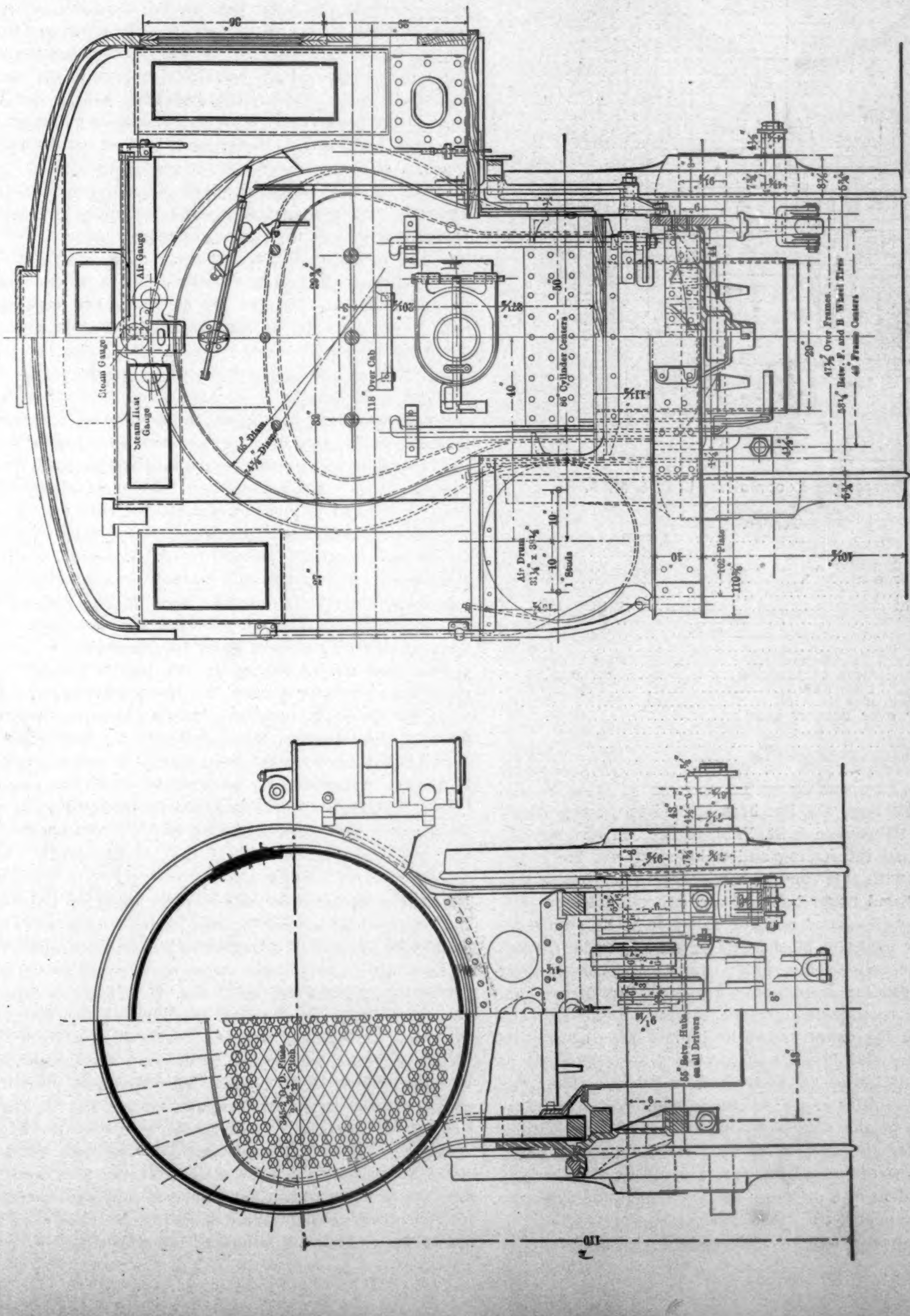
Firebox, type....................Over frames
Firebox, length....................121 in.
Firebox, width....................41 in.
Firebox, depth, front....................78 in.
Firebox, depth, back....................63½ in.
Firebox, material....................Steel
Firebox, thickness of sheet...Tube, ⅝ in.; sides, back and top, ⅜ in.
Firebox, brick arch....................On water tubes
Firebox, mud ring, width........Back, 3½ in.; front and sides, 4 in.
Grates, kind of....................Cast iron rocking
Tubes, number of....................345
Tubes, material....................Charcoal iron
Tubes, outside diameter....................2 in.
Tubes, length over tube sheets....................15 ft. ¼ in.

Smokebox.

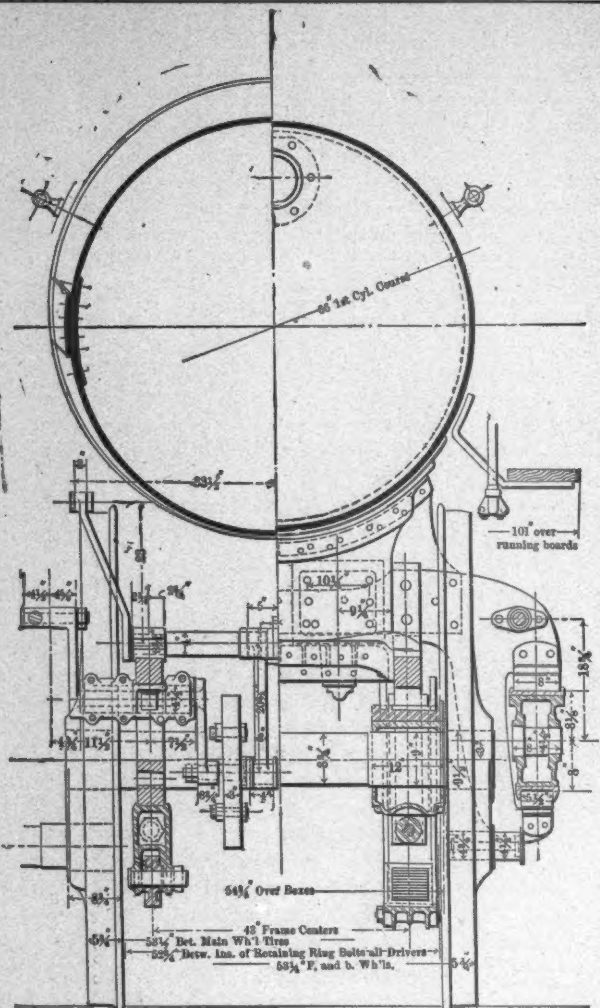
Smokebox, diameter, outside....................69 in.
Smokebox, length from flue sheet....................69 in.

Other Parts.

Exhaust nozzle, single or double....................Single
Exhaust nozzle, variable or permanent....................Permanent
Exhaust nozzle, diameter....................5⅛ in.
Exhaust nozzle, distance of tip below center of boiler.........7 in.
Netting, wire or plate....................Wire
Netting, size of mesh or perforation....................2½ by 2½ in.
Stack, straight or taper....................Steel, taper
Stack, least diameter....................15 in.
Stack, greatest diameter....................16⅝ in.
Stack, height above smokebox....................34½ in.



Ten-Wheel Passenger Locomotive—Lake Shore & Michigan Southern Ry.
Transverse Sections and Rear View.
(For Front End Section see page 346.)



10-Wheel Passenger Locomotive—L. S. & M. S. Ry.

Tender.

Type	8-wheel, steel frame
Tank, type	"U" shape
Tank, capacity for water	5,000 gal.
Tank, capacity for coal	9½ tons
Tank, material	Steel
Tank, thickness of sheets	3/16 in. and ¼ in.
Type of under frame	Steel channel
Type of springs	Triple elliptic
Diameter of wheels	36 in.
Diameter and length of journals	5½ in. by 10 in.
Distance between centers of journals	5 ft. 6 in.
Diameter of wheel fit on axle	6⅞ in.
Diameter of center of axle	5⅞ in.
Length of tender over bumper beams	21 ft. 2 in.
Length of tank	19 ft. 6 in.
Width of tank	9 ft. 10 in.
Height of tank, not including collar	54 in.
Type of draw gear	Gould

Mr. Albert J. Earling, who has been elected to the presidency of the Chicago, Milwaukee & St. Paul, to succeed Mr. Roswell Miller, has had an interesting and unique career. He began railroad service with this road as a telegraph operator in 1866 at the age of 18 and never has had any other employer. His advancement is well earned and the selection is an admirable example of what ought to be the rule on all railroads, the advancement of men within the ranks, even to the very highest positions. Mr. Earling is not only a good railroad man and eminently fitted to preside over the interests of one of the best railroads in the country, but he knows more about this road than anyone else because of having filled all grades of positions from the lowest to the highest in its operation. His success is due to ability and carefulness, combined with thorough knowledge of the details of operation. He was a telegraph operator for six years, a train despatcher for five years, and assistant superintendent for four years. In 1882 he was made superintendent of a division; in 1884 he became assistant general superintendent; in 1888, general superintendent; in 1890, general manager, and in 1895, second vice-president.

PRESIDENT FISH ON PROFIT-SHARING FOR RAILROADS.

"Is profit-sharing on railroads practical? If so how can it best be adapted?" was one of the topical questions recently propounded by the St. Louis Railway Club. Mr. Stuyvesant Fish, president of the Illinois Central Railroad, answered it as follows:

"In my opinion it is not practical because of the difference in the length of service, character of service, method and the times of employing men engaged in the work. For instance, our out-of-door work on the track is practically suspended in the Northern States for some months together, track forces being disbanded or reduced very materially every autumn. Hence, through no fault of their own, large numbers of men, while working year after year for the company, are not in continuous employment in the service and cannot get the benefits which ought to accrue for continuous employment. On the other hand, it would not be fair to those who are continuously employed, day in and day out, year after year, to put them on a par with these track laborers whose employment is, after all, only occasional. Instances might be multiplied and run through all branches of the service.

"More than twenty years ago we endeavored to work out something of this sort on the old Chicago, St. Louis & New Orleans Railroad, then running from Cairo to New Orleans, but had to give up the attempt.

"The Illinois Central has nothing in its service approaching to profit sharing, but has, for several years past, encouraged and aided those in its employ in purchasing shares of the company's stock."

Notwithstanding the great importance of statistics in the form of concise figures of performance and cost of doing work the records of a department of a large organization which permit of instant comparisons are seldom obtainable. A great deal of thought is put into systems of records, but there are probably few systems in use which may not be improved. The following quotation, offered by J. F. Deems at the recent Master Mechanics' convention, may be somewhat overdrawn, but it points forcibly to the state of the statistician's art. "What practical railroad manager has not been deviled by the statistician, annoyed, bedeviled, disgusted? Yet the weary course goes on. Away up in the loft of some office at the cross-roads country station, in the grime and smoke of the store clerk's shop, overhead in the division superintendent's office, at the shipping clerks' desks, in the maintenance of way departments—everybody, everywhere in some way or other, is making statistics. We have spent one dollar and we spend two dollars more of the stockholders' money just to explain to them where the first dollar went to."

At the completion of tests recently made on Babcock & Wilcox water-tube boilers, in the British twin-screw gun-boat Sheldrake, some interesting experiments were made. One was to ascertain in what time steam could be raised to a pressure of 140 lbs., from water at 70 deg. F. This was found to take just 23 minutes. A stopping and starting test was then tried, in which the engines were suddenly stopped from full speed. The tube, front, and uptake doors were simultaneously opened and the ash-pit door closed. The increased pressure on the gauge did not exceed five pounds; neither did the safety valve lift. A test was then made to see how soon the operation of drawing a tube could be commenced, and how quickly a tube could be drawn from the boiler after the fires were suddenly drawn and water blown out. Several caps were removed ready for tube drawing in 24 minutes, and three tubes were afterward drawn in 11, 10 and 9 minutes, respectively.

WIDER FIREBOXES.

By William Forsyth.

In the United States for many years the width of locomotive fireboxes was restricted by the distance between frames, the box extending down below the lower frame bars and the inside width of the firebox with this construction was about 33 inches. The grate area with a box 6 ft. long was 16½ sq. ft. and with one 7 ft. long it was 19¼ sq. ft. With larger engines it was found necessary to increase the grate area, and the firebox was placed on top of the frames and flush with their outside faces, thus securing an inside width of firebox of 42 inches, and it being clear of the axles any convenient length could be used. The box was made 8 or 9 ft. long, and the grate area so obtained was from 28 to 31 sq. ft. This practice was coming into general use in 1885, when 19x24 in. cylinders were considered large, and 160 lbs. boiler pressure a high one. Notwithstanding the continued enlargement of cylinders and boilers since that time it is a remarkable fact that for bituminous coal, locomotive builders still retain the same width of firebox as used 14 or 15 years ago. The width of firebox now seems to be limited to the distance between the outside faces of frames. The difficulties in construction met with in extending the firebox beyond the frames have been easily overcome in the extreme widths used on the numerous Wootten fireboxes, 8 ft. wide, which have already been built. These large fireboxes have been generally adopted by all the roads in the anthracite coal region, and the practice in the United States may now be said to be the use of fireboxes 8 ft. wide for anthracite coal, and boxes 3 ft. 6 in. wide for bituminous coal. This arbitrary limitation of the width of the firebox to 3 ft. 6 in. regardless of the size of the engine is believed to be a mistake which must soon be recognized by those who are endeavoring to obtain the maximum economy in coal burning. The large engines which have been built in recent years, when compared with smaller engines, have shown such improved economy in cost of coal per ton-mile that the effort to obtain the best possible evaporation has to some extent been neglected. The large boilers have had the advantages of greatly increased heating surface in the tubes, and for this reason the coal economy has been maintained as before, notwithstanding the fact that the rate of combustion must have been increased. The time will soon come when small engines will be obsolete and large engines will only be compared with other engines of equal size, and the best coal economy will then be found where the grate area has been properly proportioned to the steam consumption of the cylinders.

The two principal objections to very high rates of combustion on locomotives are, first, the heavy draft required; it pulls large quantities of sparks into the smokebox, taxing the spark-arresting device so that it must be modified in some way, which will invariably interfere with economical coal burning; besides the spark loss in fuel is considerable, and probably equal to all other losses due to small grates. The second important source of loss accompanying high rates of combustion is due to the high velocity of the gases in passing over the heating surface, not allowing the heat from them to be as fully absorbed as it should be.

Carefully measured tests show that spark losses under high rates of combustion are equal to 10 to 15 per cent. of the coal fired. Numerous experiments on the shop-testing plants and in road tests show how rapidly the amount of coal used per pound of water evaporated increases with high rates of combustion. In his paper on the Effect of High Rates of Combustion, Prof. Goss gives the results of his experiments with different areas of grates on the locomotive in the laboratory as follows: When coal is burned at the rate of 50 lbs. per square foot of grate per hour, 8 lbs. of water were evaporated per pound of coal; at 100 lbs. the rate was 7 lbs. of water, and at 180 lbs. only 5 lbs. of water. In the tests of compound locomotives on the C. M. & St. P. Ry., reported to the Master Mechanics' Association in 1892, we find that with Braceville coal, when the rate of combustion was 109 lbs., the rate of evaporation was 6 lbs., but when the former was increased to 156 lbs. the rate of evaporation fell to 5 lbs. Also, with Pittsburgh coal, with same series of experiments, when the rate of combustion was 80 lbs. the rate of evaporation was 7.7 lbs. of water, but when the former was raised to 100 lbs. the water rate was decreased to 6.7 lbs., a difference of one pound in the water rate in each case, due to a change in the coal rate. Tests on the C., B. & Q. R. R., with Streator coal, when the coal and water were carefully measured, showed with a coal rate of 90 lbs. per square foot of grate per hour a water rate of 7 lbs., but when the coal rate was 125 lbs. the water rate fell to 6 lbs., a difference of one pound less water evaporation, caused by a difference in the rate of combustion of 35 lbs. per square foot of grate.

It has been claimed that, even with rates of combustion as high as 200 or 225 lbs. coal per square foot of grate per hour, the combustion is complete and almost perfect, and in fact the anaylsis of the smokebox gases in the Purdue experiments showed this to be true, as there was hardly a trace of carbonic oxide and free oxygen was present. For this reason it is argued that the loss of economy due to high rates of combustion is not the result of a small grate, but is due to imperfect absorption of heat by insufficient heating surface, as is evident from the increase in temperature of the smokebox under such conditions. In Prof. Goss's experiment the heating surface was constant and the total amount of coal burned per hour was also constant, the only change being the area of the grate. The loss in economy must therefore be attributed to the reduction of grate area, even if it resulted in a failure of the heating surface to absorb a proper amount of heat due to the high velocity of the hot gases through the tubes. In the above experiments the vacuum in the smokebox when burning 61 lbs. of coal per square foot of grate was 2.2 inches of water, and when burning 240 lbs. coal per square foot it was 5.6 inches, the draft in the latter case being two and a half times as great as in the former, and the velocity of the gases through the tubes must have been correspondingly increased. If the small grate requires such a strong draft that the gases are in contact with the heating surface too short a period, it must result in a loss in economy. The heating surface in a locomotive can never be too great for it is not possible to obtain the amount necessary for maximum economy on account of the large size and weight of the boiler.

In stationary boilers good practice requires 1/5 sq. ft. grate and 10 sq. ft. heating surface for 1 horse power, and for the 1,000 horse power developed by modern locomotives, there would be required on the same basis 200 sq. ft. of grate surface and 10,000 sq. ft. of heating surface. The problem then is with all the available heating surface possible in a locomotive, what is the proper grate area for a given steam or coal consumption? Cannot the proportion of grates for locomotives be placed on a rational basis, having reference to the cylinder volume and the speed per mile? At present the general practice is to make the firebox for a bituminous coal burning locomotive 40 or 42 in. wide, and 9 or 10 ft. long, regardless of the size of the cylinders, the diameter of the wheels, or the speed, in miles per hour.

In making the grate area proportional to the cylinder volume, the dimension in the direction of length is limited to about 10 ft., on account of the difficulty of firing on a longer grate. In order to obtain larger grate areas it is therefore necessary to increase the width, and there seems to be no good reason why the width of fireboxes should be either 42 in. or 96 in., which is now the prevailing practice, but it certainly should be as much greater than 42 in. as is necessary to secure a moderate rate of combustion, corresponding to 80 or 90 lbs. of coal per square foot of grate per hour.

The locomotives with 19x26 inch cylinders, built 15 years ago, had grates 42 in. wide and 9 ft. long, and the amount of coal

required to supply these cylinders with steam was sufficient to require a strong blast, drawing sparks through the tubes and out of the stack. The grate proportions in this case cannot therefore be said to be too large. The total volume of the two cylinders is 7.87 and the grate area 31.5 sq. ft. and the ratio of cylinder volume to grate area is as 1 to 4. We regard this as a good proportion, and believe that when it is made less that the rate of evaporation is reduced. In the Master Mechanics' Committee report on Ratios of Grate Area to Cylinder Volume, read at the convention in June, 1897, the committee recommend that this ratio should not be less than 3 for simple passenger or freight locomotives. It will be found, however, that in all recent freight locomotives the ratio is less than 3, and it is evidently due to the indisposition of locomotive builders to give up an old and irrational practice of making fireboxes as wide as the frames, and no wider.

In the report referred to, the proper method of calculating grate area for locomotives, based upon the cylinder volume, is clearly explained, and we will give briefly a sufficient portion to show its application. It is assumed that the average work in the cylinder is done at one-fourth cut-off and the average speed is one-half the diameter of drivers for passenger engines, or 168 revolutions per minute, and for freight engines one-third cut-off and 120 revolutions is assumed. Then if $V =$ volume of both cylinders in cubic feet, the water per hour, from and at 212° F., will be approximately $2150 \times V$ for either passenger or freight engines. The coal consumption will depend on its quality, and for western bituminous coal, 6 lbs. water per pound of coal may be taken as a fair average, and if the rate of combustion is not to exceed 90 lbs. per square foot of grate per hour, then the proper grate area will be, in terms of cylinder volume, $\frac{2150}{6 \times 90} \times V = 4 V$. That is, the ratio of grate area to cylinder volume under the above conditions should be 4. Let us see how this compares with the ratios found for some of the large freight locomotives recently built:

The 12-wheel engine for the Illinois Central, illustrated in the October number of this paper, has cylinders 23x30 inches, and a grate 42 in. wide and 11 ft. long, having an area of 37.5 sq. ft. The cubic contents of both cylinders is 14.4 cu. ft., and $\frac{37.5}{14.4} = 2.6$. If the grate was made as large as would be required by a factor of 4 times the cylinder volume it would be $14.4 \times 4 = 57.6$ sq. ft., and if made 11 ft. long, the width should be about 62 in. The P. R. R. Class H6 freight engines, illustrated in the June, 1899, number, have cylinders 22x28 inches, and grates 40 inches wide and 10 ft. long, giving an area of 33.3 sq. ft. The cylinder volume is 12.32 and $\frac{33.3}{12.32} = 2.7$. If the grate for these engines was made 4 times the cylinder volume, its area would be 49 sq. ft., and if 10 ft. long, its width would be 58.8 inches. As an example of a recent large passenger engine we will take the 10-wheel engine for the Denver & Rio Grande, illustrated in September, 1899, number. This engine has cylinders 21x26 inches, and grate area 33.5 sq. ft. The total cylinder volume is 10.4 and $\frac{33.5}{10.4} = 3.22$, and according to the proportion we suggest the width should be 50 in., instead of 41 in.

Freight engines having driving wheels of small diameter present no difficulties in extending the firebox over the wheels. Wide fireboxes extending over the large drivers of passenger engines raise the center of the boiler rather high, but the Atlantic type is admirably adapted to the use of large wheels and wide fireboxes which do not extend over the drivers but over the trailing wheels. In either freight or passenger locomotives it is easily possible to use wider fireboxes without resorting to radical changes in the wheel arrangement or to material modifications of existing general plans.

AN AMERICAN OBSERVER ABROAD.*

II.

A Day at Horwich.

By Professor W. F. M. Goss.

The Lancashire and Yorkshire Railway centers in the city of Manchester, from which point it reaches out to the north, east and west, covering the adjacent country with a complicated network of track and embracing such cities as Liverpool, Preston, Leeds and Bradford. The trip by local train from Manchester to Horwich gives one an hour's ride among green hills, bushless and treeless, but of magnificent proportions, marked here and there by the derricks of busy coal mines. In the very midst of such hills is Horwich. Twelve years ago, or thereabouts, the Lancashire and Yorkshire Railway selected this place as the location of its general shops, and to-day employment is given to 4,000 men—a result accomplished under the immediate direction of Mr. J. A. F. Aspinall, until recently Chief Mechanical Engineer of the road.

Mr. Aspinall needs no introduction to readers of the "American Engineer," for some have gained personal acquaintance with him in the course of his repeated visits to America, and others have come to know him through his most valuable contributions to technical literature. At the time of my visit Mr. Aspinall was still Chief Mechanical Engineer, but the announcement of his promotion to be General Manager was made a few weeks later.

The shops at Horwich make all heavy repairs on 1,400 locomotives, build new ones and supply heavy forgings, all castings and all machine work needed by other departments of the road. The works include a steel mill in which steel wheel-centers are cast, tires are rolled, and lighter work in great variety is turned out. Dynamos for station lighting, electric signaling apparatus, telegraph instruments and many other articles which American railways obtain from outside sources are in the case of this road made at Horwich. The variety of processes undertaken requires space and organization, and both of these are had. The shops consist of three long parallel buildings, having tracks between them, and in some cases within them. (See Mr. William Forsyth's description of these shops, June, 1898, page 194.—Editor.) The locomotive repair shop occupies one portion of one of these buildings, and new locomotive work another portion, the two portions, while separated only by a transfer table running across the shop, being quite distinct. The steel mill is a complete establishment by itself, and the electrical department is a factory seemingly as independent of other things in its vicinity as though it were in another city.

Mr. Aspinall has succeeded in securing a high degree of uniformity in his motive power. With 1,400 locomotives he has but three different types, though the first installment of a fourth type is just now being put into service. The three types which at the time of my visit were doing the business of the road are:

(1) A freight engine having six coupled wheels 61 inches in diameter;

(2) A tank engine having four coupled wheels 68 inches in diameter, and two 2-wheel trucks, one leading and the other following the drivers; and

(3) An express passenger engine having four coupled wheels 87 inches in diameter, and a 4-wheeled truck leading the coupled wheels.

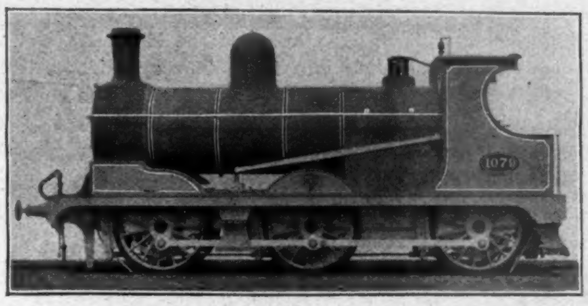
The engines weigh 68, 59 and 68 tons respectively. All have cylinders of the same size (18x26 inches) and the tank engine and the passenger engine have boilers which are identical. Moreover, the boilers of all the engines have 50-inch shells, 200 tubes 1¾ inches in diameter, and a firebox of standard dimensions.

All engines have plate frames and are inside connected. Joy

* For previous article see October issue, page 313.

valve gear is exclusively used and its details are so well designed as to give a very stiff arrangement.

It was at Horwich that I first saw the parts of an English engine, both before and during the process of erection. Very little machine work goes into the frame. Plates for the sides, an inch in thickness, two or three feet in width, and thirty feet, or so, in length, are piled and milled to bring the edges to proper outline. When thus reduced to the desired form, two plates are set up to form the sides, the cross-bracing is riveted in, castings to give bearing for the axle-box wedges are added, and the frame is practically done.

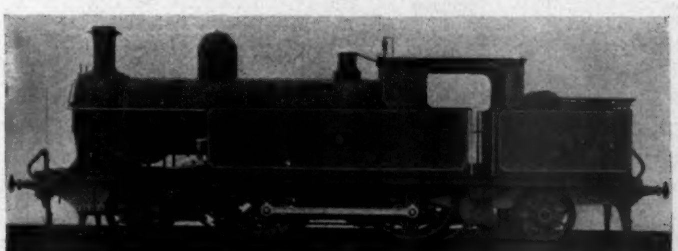


Lancashire & Yorkshire Standard Locomotives.
Six-Coupled, Freight.

The front of the boiler is supported from the frame and not by the cylinders, as in American practice. The latter are slipped up between the frames and are bolted to the side-plates; while easily removable, they have a very secure place provided for them, and they certainly have the appearance of being well protected and quite warm as they nestle close together. The exhaust passages are so direct that by looking into the exhaust tip one may see the slide valve. I was told that an engine coming in with broken cylinders could have the old pair removed and a new pair applied, ready for the road again, in four hours from the time of its arrival in the shop.

With the inside connection, the coupling-rod pin on the outside of the main driver is put opposite the inside crank, the wheel crank pin and coupling rod thus serving in part to balance the axle crank and the main rod. A light counterweight in the rim of the main driver is, however, necessary, and while entirely correct, it looks odd at first sight to see the wheel going with the crank and counterbalance on the same side of the center.

But I imagine that the inside-coupled engine, though it has many good points, will not always live even in England, for here, as in America, one manifestation of progress in railroading is a desire for more powerful locomotives. A response must involve larger cylinder volumes, and as no considerable increase over present maximum dimensions is possible under existing practice, the cylinders will in the end come outside of the frames.



Lancashire & Yorkshire Standard Locomotives.
Local Passenger and Freight.

Mr. Aspinall forges his crank axles in a very ingenious manner. The forging, properly speaking, begins with a blank of uniform section, which for an 8-inch axle carrying cranks for 26-inch stroke, would, I judge, be about 8½ inches thick, 20 inches wide and 5 feet or more long. The forging consists in cutting the required axle out of the solid material of such a blank, the cranks are cut, lying in the same plane and together. The process begins with eight cuts by the hot saw partially across the blank—four being made from one edge and four from the other. These outline the webs of the cranks. From the saw the blank goes to the steam hammer, where the blocks between the several webs and between the outside webs and the ends of the axle, are chiseled out, and I presume that this operation is followed by some hammering to round up the wrist pins and the body of the axle, but I did not see this done. Finally the middle portion of the axle is twisted to bring the two cranks at right angles. This finishes the forging. The blank from which the axle is cut weighs three times as much as the finished piece, but no considerable loss results, since the material cut away is in the form of large blocks and serves as stock from which smaller forgings are made.

The axle blanks are shaped up preparatory to the forging, by means of a hammer of the battering-ram type. It consists of two immense masses of iron carrying suitable dies, and mounted on a horizontal bed-plate, upon which they are made to travel by suitable steam-driven mechanism. In preparation for a blow the masses separate, and returning they impinge simultaneously on opposite sides of the work interposed between them. The machine is from an old design, a similar hammer having been installed at Crewe very many years ago, where it is now referred to as a "Ramsbottom horizontal duplex hammer." The Horwich machine is rated at 35 tons, a value which, I presume, represents the weight of each of the two masses. It is apparent that such a hammer, while requiring no heavy foundation, gives a blow which, because of the weight and slow motion of the masses, is most efficacious in its effect on hot metal. But it is not adapted to general forging, its best work being on sections of plain outline.

Lancashire & Yorkshire Standard Locomotives
Express Passenger.

The labor cost of finishing a crank axle from the forging at Horwich is but $15. From an officer of another road purchasing axle forgings, and probably having lighter machines upon which to finish them, I learned that when axles are bought rough from the forge the labor cost for finishing is about $25, but when purchased rough-turned, the piece-work price for finishing is from $9.25 to $10, depending on the size of the axle. I may add that failures of crank axles are of rare occurrence. I was told by a chief of motive power having 1,600 axles in service, that he had had but three failures in eight years, two having been detected when the engines were in the shop, and the third having occurred on an engine engaged in yard work.

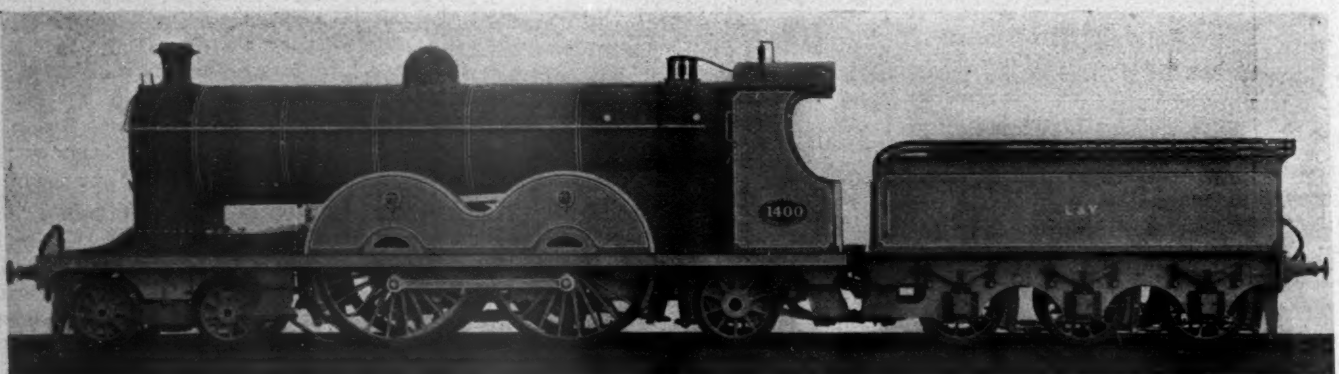
I have already stated that Mr. Aspinall was at the time of my visit in the process of adding to his equipment a fourth type of engine. This is for heavy passenger service. As compared with those already described it presents differences quite similar in character with those which mark recent changes in American practice. Thus, while the volume of cylinders has been increased somewhat, the most significant change is

to be seen in the diameter and extent of heating surface of the boiler.

The new engine weighs, with its tender, about 90 tons, and its four coupled wheels are 87 inches in diameter. A four-wheeled truck leads the coupled wheels and a two-wheeled truck follows them. The cylinders are 19 by 26 inches, and are steam-jacketed in barrel and heads. The valve motion, like that of all other engines of the road, is the Joy, in connection with which is a steam reversing gear. The boiler, while only 58 inches in diameter of shell, presents a trifle more than 2,000 feet of heating surface, an increase of about 50 per cent. as compared with the boilers previously used by the road.

In speaking of the considerations which had led to the adoption of the steam jacket for the new type of engine, Mr. Aspinall explained that the service of his engines involved frequent stopping, and the hilly character of the road permitted considerable drifting without steam, both of these conditions resulting in the cylinders being more or less cooled at frequent intervals. He held that such conditions are not favorable to the compound engine, and argued that jackets, by keeping the cylinders always hot, must operate to diminish the loss arising from the cooling which otherwise occurs when steam is shut off. In response to my suggestion that jackets had been often found inefficient because of imperfect drainage, he replied that he had anticipated that difficulty and had found its perfect solution in carrying the steam supply for the large injector through the jackets, experience having shown that the injector thus supplied gave no trouble whatever.

Another detail of the new engine which was novel to me is the steam reversing gear, though I afterwards found such a mechanism to be not uncommon in English practice. Those who have used it agree that it serves its purpose excellently and is not troublesome in the matter of repairs. In principle it is in every way similar to the starting gear generally employed on various engines. A steam cylinder does the work and a water cylinder prevents shocks and a too rapid motion. As applied by Mr. Aspinall, the two cylinders are placed horizontally one above the other, but the most of those which I saw were in general appearance like a half-sized Westinghouse air pump. The apparatus is placed in a position corresponding to that of the reverse lever quadrant of the American engine. I did not see the apparatus work at Horwich, but an engineer of the Glasgow and Southwestern, whose train was awaiting at a station had evident pleasure in making me acquainted with its operation. By manipulating two small handles he moved the link by a succession of very short steps, from the full-travel position to the center, and back again to full travel. Then he repeated the operation, using longer steps, and a third time by still longer steps, and ended the exhibition by entirely reversing in a single movement, throwing the link first one way, then the other, in rapid succession, all in much less time than it takes to tell it. He explained, however, that it would not work quite as quickly when steam was on, but was emphatic in his opinion that the gear was vastly superior to the screw which is the more common arrangement in England.



Lancashire & Yorkshire Standard Locomotives.
FAST PASSENGER SERVICE—NEW TYPE.
Designed by MR. J. A. F. ASPINALL.

GAS ENGINES AND PRODUCER GAS.

Jersey City Terminal.
Erie Railroad.

Results Attained.

That 100 indicated horse-power may be obtained in the vicinity of New York for 10 hours at a cost for fuel of but 60 cents may seem to be an extraordinary statement, but a careful examination of the results attained at the new power plant at the Jersey City terminal station of the Erie Railroad will prove convincing that this is a fact. The actual cost is less than this, but a statement of the exact cost of the coal used is not permissible. This result is obtained by the use of Otto gas engines driven by gas made from fine anthracite, rice size, in Taylor gas producers built by R. D. Wood & Co. The possibilities for economizing in the cost of power by such installations are so important and so great that careful attention to the following description is assured.

Reason for the Installation and Factors Employed.

A battery of six old locomotive boilers had been in use at this terminal for a number of years for heating the buildings, furnishing steam to drive the compressors of the Pintsch gas plant and for heating passenger cars standing in the yards. Some power was also required for electric lighting. It became necessary to increase the capacity of the boiler plant and to improve the economy of its operation. After considering the

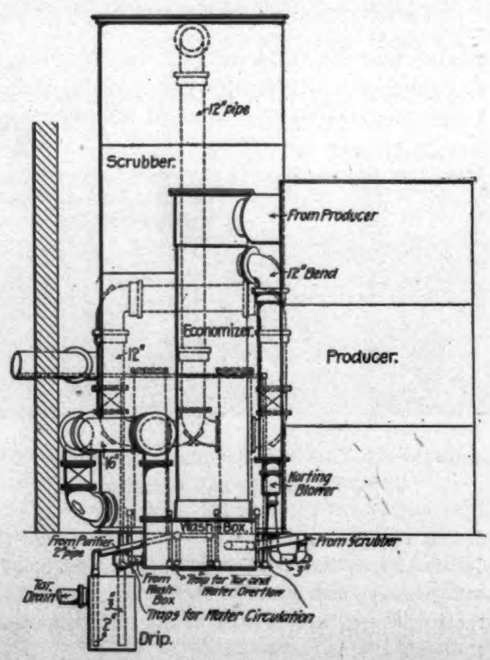


Fig. 3.—Producers—End Elevation.

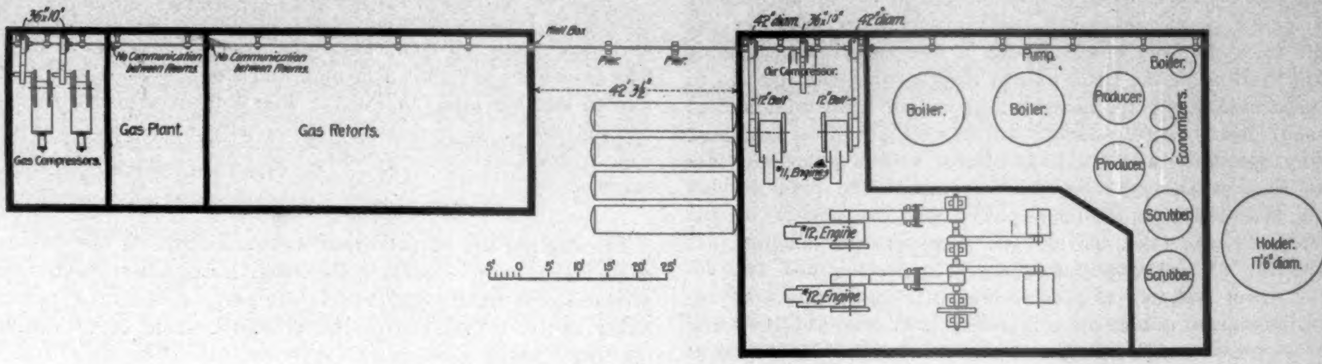


Fig. 1.—General Plan of the Entire Plant.

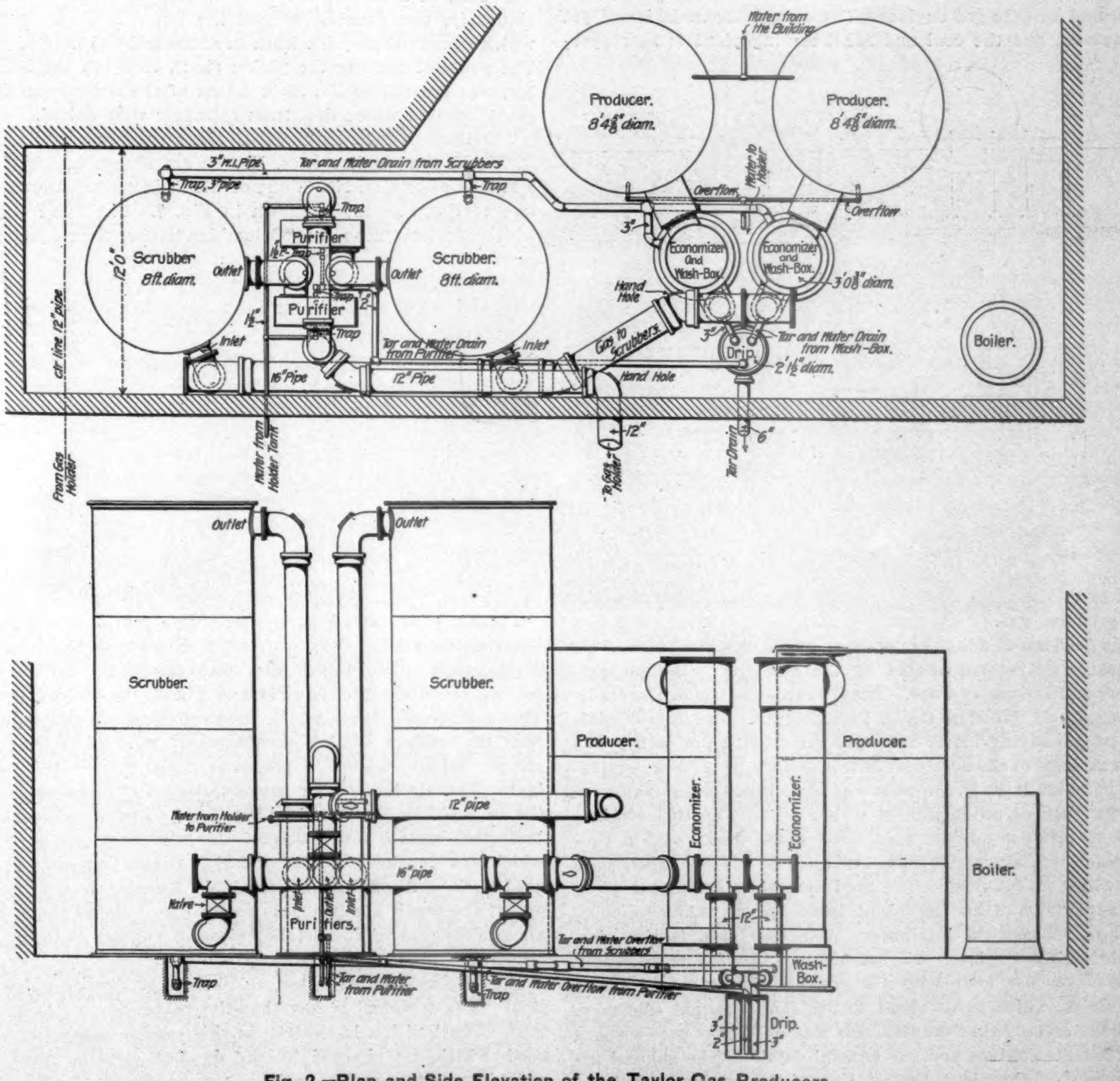


Fig. 2.—Plan and Side Elevation of the Taylor Gas Producers.

GAS ENGINES AND PRODUCER GAS.

JERSEY CITY TERMINAL, ERIE R. R.

use of modern high class boilers and steam engines, with a view of burning fine anthracite instead of the very expensive lump coal formerly used, it was decided to put up an entirely new power plant, using gas engines driven by producer gas made from the very cheap grades of fine anthracite available along the line of the road, and to install two steam boilers to be used exclusively for heating purposes in the winter and to be shut down entirely during warm weather. The estimated saving was large and the total cost of such a plant was less than that of an equivalent steam plant. The plan decided upon included two 400-horse-power vertical boilers of the Morrin, Climax type, Taylor gas producers of sufficient capacity for 400 indicated horse-power in gas engines, two 90-horse-power and two 45-horse-power Otto gas engines, an Ingersoll-Sergeant duplex air compressor, belt driven, a 130-2,000-candle-power arc light machine, a 450 light incandescent machine and the necessary accessories. The whole plant is arranged in duplicate, and in addition to the power used at the terminal station the producer gas is piped about 1,200 feet to the locomotive coal chutes and ash handling plant, also operated by Otto gas engines. The connecting main is not yet completed and the coal and ash handling plant is now oper-

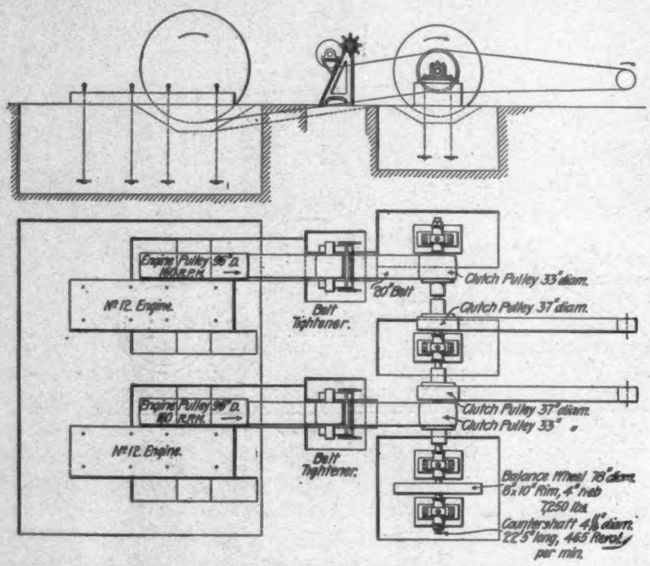


Fig. 4.—Plan of Large Engine Foundations.

ated by city gas, the cost of which is about three times that of the producer gas.

The decision to adopt gas engines was influenced by the very favorable guarantees offered by the builders of the gas producers and the gas engines. The guarantee of the producers by Messrs. R. D. Wood & Co. of Philadelphia called for 80 cubic feet of gas having 125 B. T. U. per cubic foot from each pound of anthracite buckwheat coal of fair quality, this being equivalent to 10,000 B. T. U. per pound of coal, which is equivalent to an efficiency of production of 80 per cent. The Otto engines were to produce an indicated horse-power hour with a consumption of not more than 1¼ pounds of good anthracite buckwheat at full load. The producers were afterward given the advantage of an important improvement which enabled them to surpass the guarantee. The coal used is rice size, which is almost refuse. The gas engines produce an indicated horse-power per hour with the consumption of about 12,000 heat units, which gives about 22 per cent. thermal efficiency.

We understand that the Otto Gas Engine Works were responsible for the engines and the general details. The general arrangement of the plant, the location of the producers, boilers, gas engines and compressors for air and Pintsch gas may be seen in the engravings. The Pintsch gas plant was built several years ago and the power plant was provided for in a new building adjoining. The entire plant is on "made land," which required piling foundations throughout, including the building. The arrangement and plan of the gas plant, producers, scrubbers and purifiers were in the hands of R. D. Wood & Co. of Philadelphia.

The plan of the entire installation is shown in Fig. 1, in which the relative location of the producers, gas holder, boilers, gas engines, air compressor and gas compressors are given. The producers are shown in plan and side elevation in Fig. 2, and in end elevation in Fig. 3. Fig. 4 illustrates the belting connections of the two large engines, and the general drawing, Fig. 1, gives the corresponding information as to the small engines.

The Gas Engines.

The engines are of two sizes, known as Nos. 12 and No. 11, guaranteed to give 90 and 45 actual horse-power each with producer gas having 125 heat units per cubic foot. The exhaust is led to vessels on the ground outside of the building, from which pipes run to the roof. Clutches are provided for all the engines so that one or both of each size may be used. The gas compressors, which are of the Pintsch type, were changed from direct steam to belt driving. This work was done in a novel way. The compressors run almost continuously, one running 20 and the other 24 hours per day, which necessitated quick work in making the change of power. The pedestal holding the pinion shaft, carrying the belt pulley, was secured to the main frame of the compressor in the exact location where the steam cylinders were bolted.

The large No. 12 twin cylinder gas engines are illustrated in Fig. 5, the smaller ones, No. 11, are shown in Fig. 6, and a still smaller size, No. 8, one of which is used at the locomotive coaling station, is shown in Fig. 7. The large engines, which are known as the "Columbian" type, each develop 106 actual horse-power and 139 indicated horse-power. These engines are belted to the line shaft, from which two generators are driven, one for arc and the other for incandescent lights. There are two cylinders, one above the other, working on the same crank pin, and giving an impulse at every revolution. This type of engine gives a very steady motion, as may be seen by watching the lights. The amount of gas is in direct proportion to the power and is regulated by the governor. These builders make a specialty of horizontal engines running at slow speeds to avoid excessive wear. The parts are easily accessible without dismounting the whole engine. The lubrication is by automatic sight feed lubricators on all bearings and on the cylinders. The gas, air and exhaust valves are all placed in separate castings easily removable and provided with water channels for cooling.

The No. 11 engines, Fig. 6, develop 50 actual and 60 indicated horse-power each. They are belted directly to the long line shaft driving the Pintsch gas compressor, the coal elevator for the producers and, as shown in Fig. 1, the air compressor. This compressor, made by the Ingersoll-Sergeant Co., is placed near the engines. It has a capacity of 380 cubic feet of free air per minute against a pressure of 100 pounds per square inch. The air is used for brake testing and cleaning cars in the yards. The No. 8 engine, Fig. 7, develops 38 actual and 42 indicated horse-power. One of this size and one of No. 6, which will develop 19 actual and 21 indicated horse-power, are used at the coal and ash hoist. A No. 6 engine is also used at one of the repair shops of this road. Fig. 7 shows the appearance of several of the smaller sizes of engines built by this concern.

The Otto gas engine is too well known to require a description. It is sufficient to say that the valves are of the poppet type. The ignition is electric, in this case storage cells being used, which are charged by the dynamo circuits, making a reliable and thoroughly satisfactory arrangement. The governor not only regulates the speed and gas consumption but it cuts off the gas supply in case the engine stops for any unforseen reason, preventing the escape of gas from the engines. It also permits of changing the speed without stopping the engine. It is interesting to watch the No. 11 engines running the air and gas compressors. The load is very variable be-

cause the air compressor, which takes about 50 horse-power, is thrown on or off suddenly by the automatic regulator, and yet the speed is so uniform as to appear to be perfectly steady. Salt water is pumped from the river to cool the cylinders of the gas engines and the air compressor in warm weather, and in the winter, while the steam heating boilers are needed, fresh water will be used and the heated water will be fed into the boilers by the feed pumps. This method avoids the use of city water in summer.

The Taylor Gas Producer.

The gas producers are of the Taylor automatic type, with economizers, furnished and installed by Messrs. R. D. Wood & Co. of Philadelphia. The essentials of a gas producer are complete combustion of its carbon, uniformity in quality of gas, ease and continuity of operation. The operation consists of combustion of the coal within an atmosphere containing insufficient oxygen to completely burn it. For a successful producer the conditions may be summarized as follows:

1. A deep fuel bed carried on a deep bed of ashes; the first to make good gas and the second to prevent waste of fuel.
2. Blast carried by a conduit through the ashes to the incandescent fuel.
3. Visibility of the ashes, and accessibility of the apertures for their removal, arranged so that operator can see what he is doing.
4. Level, grateless support for the burden, insuring uniform depth of fuel at all points and consequent uniformity in the production of gas.

In this producer, shown in Fig. 9, there is no grate to waste coal through, and there is practically no waste in cleaning. The deep ash bed permits the coal to burn up clean, and in practice the carbon is frequently gasified so that less than one-half of one per cent. of the original carbon remains in the coal. Any clinkers that will pass through a six-inch space will be discharged from the producer in regular grinding without any manipulation or waste of fuel, and this distance may be increased if desired. Cleaning is done without stopping the producer for a moment and the quality of the gas is only slightly injured for a short time, hence the producer is practically continuous, and at the same time it is just as perfect an apparatus when used intermittently. By the use of the test or sight holes in the walls, the attendant always knows when to grind down his ashes and when to stop. In grinding down the ashes the settling of the fuel is active next to the walls or it may be said that the settling is more from the walls to the center. There is nothing to burn out, for the top of the iron work is six inches below the fire, and the lower part of the producer is nearly cold. There is nothing to wear out, for all the parts are heavy castings, and in ordinary working the table revolves only three or four times in a day.

Details of the Producer Plant.

The producers as well as the engines are in duplicate. They are 7 feet in diameter by 15 feet high, and are fitted with a bucket fuel elevator and Bildt automatic feeders. The gas passes from the producers into the vertical economizers, where it is cooled by giving most of its heat to warm the blast of air used in making more gas. The air draft is produced by a Korting steam blower, the steam being supplied by the small upright boiler in the corner of the house. In summer this is the only steam required about the plant. The gas enters at the top of the economizer and passes out through a wash box below. The air is drawn up from the bottom of the economizer, passing out near the top, where the hot gas enters. The wash box removes a large part of the tar and acts as a seal to prevent the gas in the holder from passing back into the producer. From the wash box the gas passes to the base of the large vertical scrubber, which is of the character usually found in gas works. Its compartments are filled with coke wet by sprays of water. The purpose of the scrubber is to remove ammonia, and most of the tar and sulphur from the gas. The remainder of the tar is removed in the purifier, a rectangular box filled with specially prepared material; this also removes more of the sulphur. The purification is not complete, but the gas is clean enough for use in the engines when it leaves the purifier and passes into the gas holder for storage until it is drawn through the main to the engines. The gas holder is 18 feet in diameter by 12 feet deep, floating in a steel tank 19 feet 6 inches in diameter by 12 feet deep. It stores a supply of gas sufficient for about ten minutes running and serves to balance irregularities in the consumption and mixture of the gas. A drip pot receives all the tar drained from the producer plant and discharges the surplus automatically into the sewer. Water is carried from the tops of the producers into the gas holder tank in winter to prevent freezing. The coal is elevated from the ground, where it is delivered by hopper cars on a trestle, and is stored in a bin elevated about 30 feet, from which it runs by gravity into the automatic feed attachment, which dis-

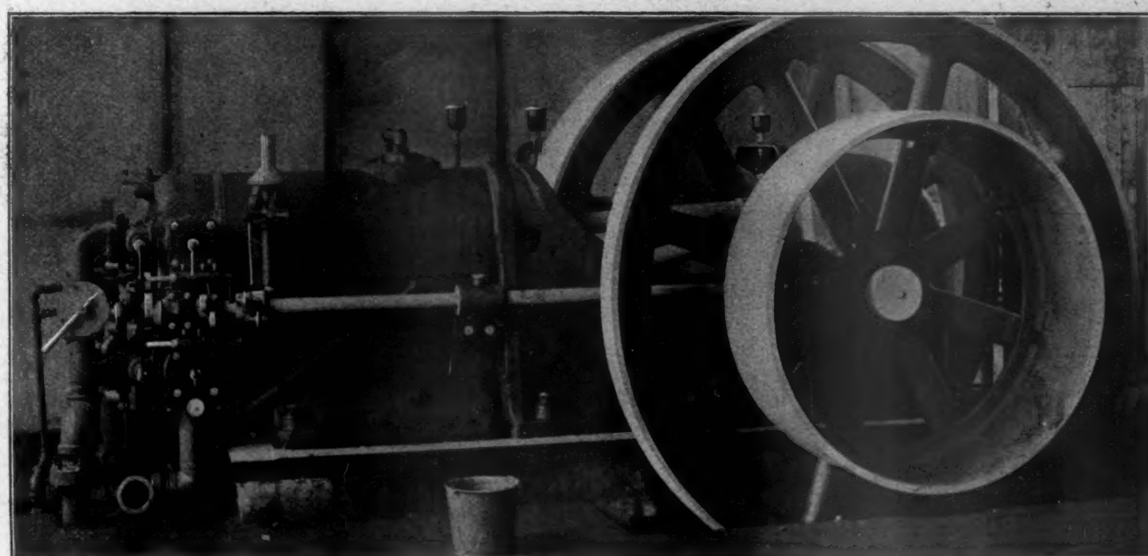


Fig. 5.—One of the Large Otto Gas Engines No. 12.

THE OTTO GAS ENGINE WORKS, PHILADELPHIA, PA.

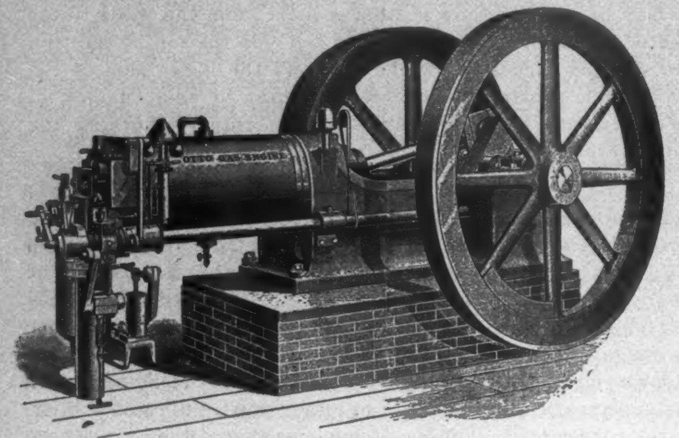


Fig. 6.—No. 11 Otto Gas Engine.

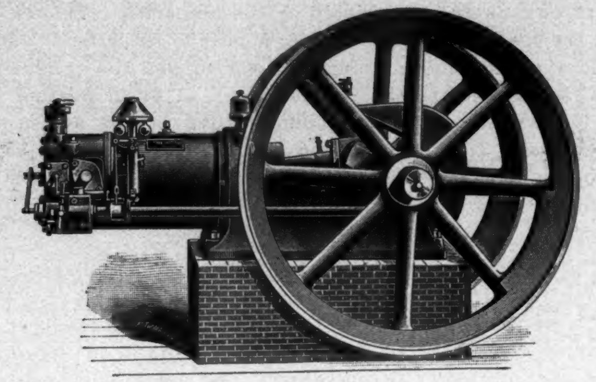


Fig. 7.—No. 8 Otto Gas Engine.

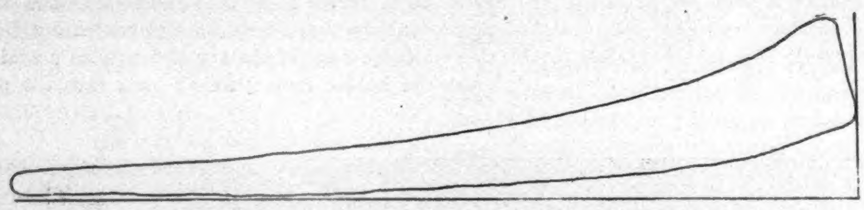


Fig. 8.—One of the Indicator Cards Taken in the Test.

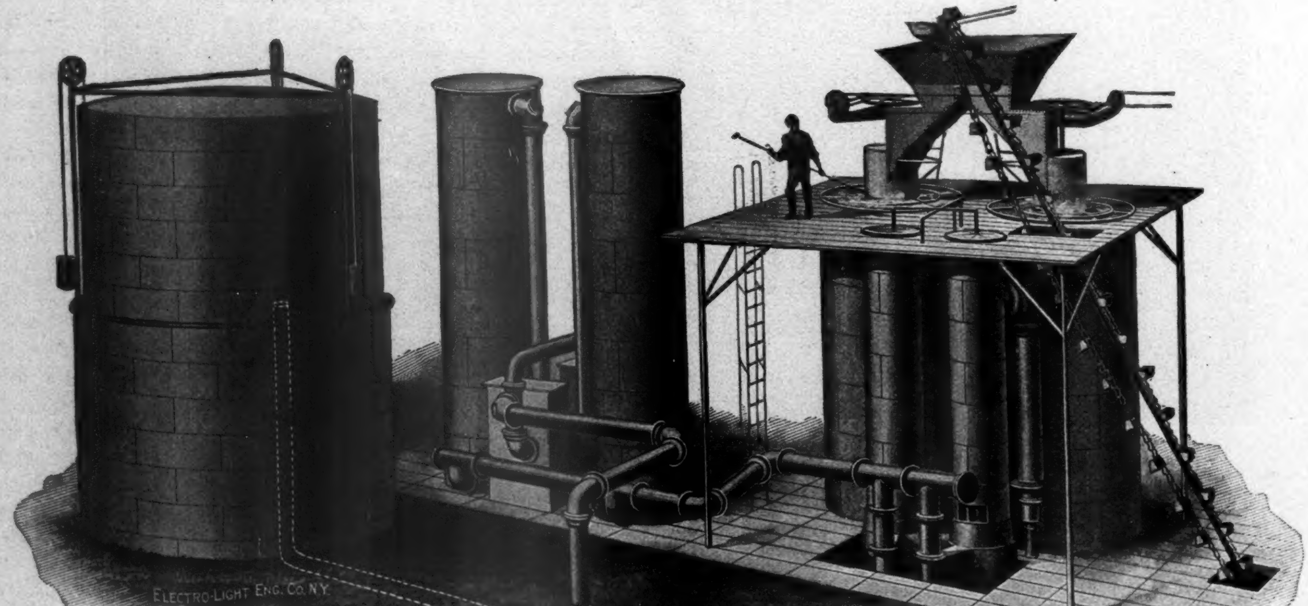


Fig. 9.—Taylor Gas Producers, with Economizers, Purifiers and Scrubbers.

R. D. WOOD & Co., PHILADELPHIA, PA.

tributes it continuously and uniformly over the gas producing surface.

Tests.

In a test made last June by the mechanical department of the road the following figures were taken from one of the large engines:

Cylinder	14⅝ by 25 inches.
Revolutions per minute	176
Duration of test	30 minutes.
Cubic feet of gas total	2,417.5
Pressure of gas	2⅛ inches.
Average horse-power during tests (one cylinder)	52.2
Average horse-power of engine	104.4
Cubic feet gas per horse-power hour	92.6

One of the indicator cards is reproduced in Fig. 8. This was taken at 170 revolutions per minute, giving 54.5 pounds mean effective pressure and 49.16 horse-power. The gas, when analyzed by the builders of the producers, gave the following results:

Carbonic acid	8.6
Oxygen	0.4
Carbonic oxide	17.2
Hydrogen	18.3
Marsh gas	2.4
Nitrogen (by difference)	53.1
Calorific power per cubic foot	136.3 B. T. U.

In another analysis the gas was found to have 142.9 B. T. U. per cubic foot, and as the engine used 92.6 cubic feet per horse-powers hour the engine developed one horse-power hour on

13,235 B. T. U. and one horse-power hour on a consumption of 1.03 pounds of coal. The analysis of the coal is as follows:

Moisture	1.62	per cent.
Volatile matter	7.50	"
Fixed carbon	78.32	"
Ash	12.56	"

About 93 per cent. of the coal is used to generate the gas, the remaining 7 per cent. being required for raising the steam. The tests showed that 84.7 cubic feet of gas were made per pound of coal, having 142.9 B. T. U. per cubic foot or 12,102 B. T. U. per pound of coal, while the guarantee called for 80 cubic feet at 125 B. T. U., or 10,000 B. T. U. per pound. The engines were guaranteed to give a horse-power hour on 1.25 pounds of coal. They actually gave this on 1.03 pounds. The figures show that both the engines and the producers more than fulfilled the promises. The producers proved to have a capacity for 471.4 horse-power instead of 400.

Operation.

One man looks after the producers. Another with a helper tends the engines and the electric machinery. There is no difficulty in starting the engines; hand pumps are provided, but compressed air, being available, will be used for this purpose. If anyone is doubtful about the reliability of gas engines used under these conditions he should visit the plant and note the regularity and smoothness of its operation, which appears to justify the same amount of confidence imposed in the best possible steam engine installation.

The Future of the Gas Producer.

This plant is important because it gives an insight into the possibilities of cheap power when the lower grades of anthracite coal are available. Producers have made little progress in this country, though they are used more generally abroad. It seems clear that power may be produced in this way for less than half the cost of steam and with no greater outlay for plant. Power, however, is not the only use to be made of producer gas. Furnaces may be fired with it and it may be burned under steam boilers. Even where steam is required for heating, this system offers advantages in that the producers require very little attention and the same gas may be used for engines and for boilers. The coal may all be handled at one place and the gas sent to any reasonable distance for distribution to engines scattered over a large plant. With proper gas storage facilities the producer plant need not be large enough to keep up with the demand in the day time and the distribution of power in such a case as the one described seems to have important advantages not possessed by any other system. The progressiveness of the officers of the Erie Railroad is to be commended in this connection and there seems to be no reason to expect anything but a continuance of the good results which are now being obtained.

We acknowledge indebtedness to Messrs. H. F. Baldwin, Engineer of Maintenance of Way, and A. E. Mitchell, Superintendent of Motive Power of the Erie Railroad, and to the officers of the Otto Gas Engine Works and R. D. Wood & Co. for information and facilities used in the preparation of this description.

The Chicago elevated roads carried a very large number of people "Chicago Day," October 9, and probably exceeded all of their previous records. The totals on the various roads were as follows: Metropolitan, 186,390; South Side (Alley L), 169,987; Lake Street, 85,438, a total of 441,815. From 9 to 11 p. m., were the rush hours, during which time the crowds went home after the evening parade. From 9 to 10 more than one train per minute averaging 5 cars per train was handled over the the downtown loop which is used jointly by all of the elevated roads. In 17 hours, from 7 a. m. to midnight, 1,002 trains with a total of 4,702 cars, were handled over the loop, which means one train nearly every minute during this time. This enormous traffic was handled with no delays and no accidents and the test speaks well for the "loop" principle in elevated railroads.

INTERESTING FACTS CONCERNING THE WESTINGHOUSE GAS ENGINE.

A few years ago there were thought to be difficulties in the way of using gas engines of more than about 100 horse-power and it was generally predicted that this type could not be considered a competitor of steam for this reason. The Westinghouse engine has proved that this opinion was entirely wrong and there is now a good prospect of building very large gas engines. The Westinghouse engine was at first confined to small powers and the idea of building one of 225 horse-power was considered at least a doubtful experiment. This size has now become popular and a 650-horse-power, three-cylinder gas engine of this type has been running in the works of the Westinghouse Electric & Manufacturing Company for over a year with perfectly satisfactory results. This, however, is not the limit of size, for a 1,500-horse-power engine, with three cylinders 34 by 60 inches, for direct connection to an electric generator, is now under way. The patterns are all finished and the castings are being made. This engine will be 44 feet long over the generator, 12 feet 4 inches wide over the bed plate and 27 feet high. It will have a 19-foot fly wheel, will run at a speed of 100 revolutions per minute and will develop 1,500 brake horse-power. This is much larger than a steam engine of equal power because it is single acting and has only half as many impulses as a single-acting steam engine, although the initial pressure is about 400 pounds per square inch. The Westinghouse gas engines are rated in terms of brake horse-power because these builders do not consider the indicator a satisfactory device for measuring power when the pressures are so suddenly applied, and for the further reason that a conservative rating is specially desired in order to insure a surplus of power to meet requirements in emergencies.

With natural gas having 1,000 British thermal units per cubic foot these engines give a horse-power hour on a consumption of about 12 cubic feet, and often less, down to about 9 cubic feet. Varying the load of course affects the efficiency because of the relatively high internal friction of this type of engine. The friction does not change materially with the load and the loss becomes a larger proportion of the power as the load decreases. At half load of some of the engines tested the consumption of gas was increased about one-third. The compression in these engines is to about five atmospheres. The temperature of the exhaust is probably about 600 degrees F. It is not high enough to heat the exhaust to the point of redness visible in the dark, but it must be near that point. The water in the cooling jackets is generally kept down to a temperature below 212 degrees. It may be hot enough to evaporate, but this is not considered advisable because of the deposit of scale which would be formed. About four gallons of water per horse-power hour is generally used through the jackets when there is no evaporation. Noise of the exhaust, which has been troublesome with gas engines, has been "killed" by turning a little water into the exhaust pipe and by using exhaust pots, or mufflers, in series.

The question of lubrication of the cylinders and connecting rods in these engines has been disposed of very easily. The oil in the bottom of the crank case furnishes all the lubrication required inside the engine. The oil splashed up by the crank end of the connecting rod works up even to the top of the cylinder and past the piston in spite of the high pressures used. The oil is of high fire test, distilled down to the correct density, and is not made by mixing oils of different densities to secure the desired result. Experiments are now being made looking to the use of this engine with producer gas made from bituminous coal, but the results are not yet given out.

These facts were brought out in a discussion of a paper on the Westinghouse gas engine read by Mr. H. E. Longwell at a recent meeting of the junior members of the American Society of Mechanical Engineers.

BOX CAR ROOFS.

It may be possible to build box cars, and even large ones, so that they will not twist and vibrate under the stresses of service, but it is impracticable to build them so, because of the increase of weight which such construction would involve. Cars are well braced against vertical and fairly well braced against lateral stresses, but the nature of the roof framing is generally not such as to offer much resistance to bending and twisting. Greater strength may be given by means of diagonal rods placed in the roof, and by double boarding, but there seems to be nothing short of too heavy construction that will make the car really rigid. The roof certainly is not the place to stiffen the frame, and it may be accepted that cars must have a large amount of flexibility to which the roof must accommodate itself without leaking. This is clearly expressed in the following statement made before the Southern & South Western Railway Club two years ago:

"A car roof must be flexible, not in parts but as a whole; it must be covered with material as nearly indestructible as possible; nails must be dispensed with where possible; it must be secured in such a manner as to make it water tight, yet each and every part must be left free to adjust itself to the twisting, swinging, cambering or swaying of the car body."

The ideal car roof is one that will remain tight throughout the life of the car, and it should give equally good results in the low temperatures of northern winters, and the heat of the South in summer. It should be durable under the feet of the trainmen and should be protected from injury from the inside. These features were appreciated eleven years ago, as the following quotation from the proceedings of the M. C. B. Association shows:

"Your committee also expressed their opinion on what is needed to make a durable and substantial roof, that would not only last the lifetime of a car without continual repair, but would actually increase the lifetime by giving such protection as would prevent leakage and decay in all latitudes—a roof protected on the under side as well as on the top, and doing service as part of the car frame to stiffen and strengthen it. It is quite evident that the plastic type of roof (that is, the asphalt roof and other compositions) is fast coming into favor, and doubtless is the equal of the present types of metal roofs in use. Both systems, plastic and metal, have about equal footing, and neither can be ignored, even were your committee disposed so to act. Your committee would therefore recommend that boards (say seven-eighths inch thick and matched) be laid longitudinally, on the carlines, for the protection of the waterproof material on the under side, as well as adding stiffness and strength to the car frame; on this bottom lay the waterproof material—iron, asphalt or other composition."

A committee of the Central Railway Club last March confirmed the importance of inside protection. "We would recommend the laying of a course of sheathing on the under side of ceiling, lengthwise of car, as a protection against frequent punctures of the metal sheets when loading and unloading freight. The cost of such sheathing would amount to not over $8 per car, and would save many times that amount in repairs and claims for damages to freight."

It seems possible to use metallic water-proofing material in such forms as to admit of the necessary flexibility, but a durable and flexible material that will not harden or crack and which may be secured without puncturing with nails seems to be the most promising practice yet taken up. A favorable argument for this form of roof is that an under sheathing is necessary. This does not add much expense or increase the weight to a serious extent and it does add to the strength of the car. Flexibility is necessary, and the best roof is that which provides this attribute in the most satisfactory way. The integrity of the roof becomes more important as the capacities of cars increase, and damage claims with leaky roofs will not be less than in the past with small cars. Present indications point to the plastic or torsion proof types as best meeting the necessities of the case.

NEW BALDWIN-WESTINGHOUSE MOTOR TRUCKS.

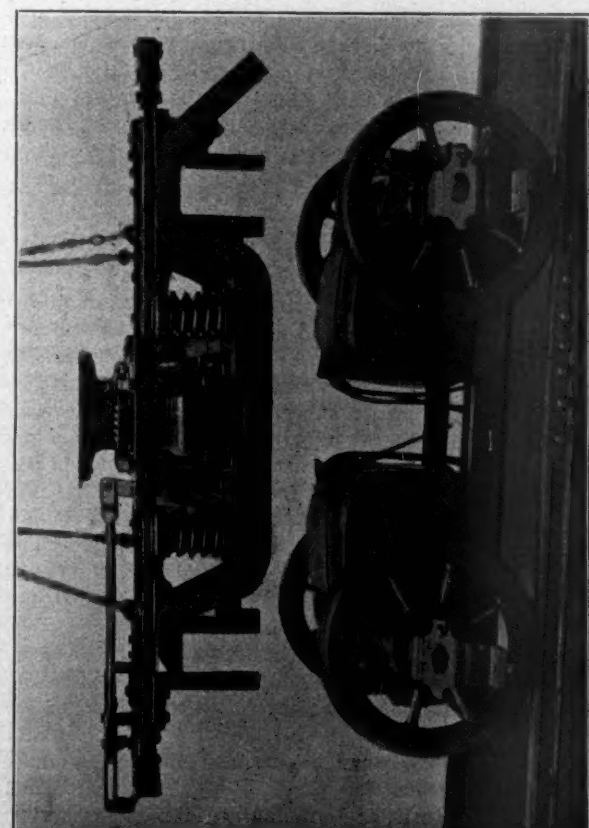
The accompanying engravings illustrate new motor trucks for elevated and suburban railroad equipment built by the Baldwin Locomotive Works and designed by Mr. George Gibbs, Consulting Engineer for these works and the Westinghouse Electric & Manufacturing Company. This design was made to meet the requirements of heavy train service, involving rapid acceleration and powerful application of the brakes, the design being in accordance with experience in the construction of car and locomotive trucks. The essential features of standard passenger car trucks have been combined with those of locomotives, in which tractive power stresses are provided for.

The motor suspension differs from the usual practice of hanging the motor frame to the truck transom, which involves the subjection of half of the weight of the motor and a large component of its torque upon the spring rigging. This method, by adding to the duty of the springs and requiring heavy, stiff springs, produces hard riding and has a tendency to tip the truck frame and cause the journal boxes to bind in the pedestals. The new design carries the weight of the motors on the axles and independently of the truck frame. The motors are carried in frames of their own, the end members of which act as equalizers and are supported by means of hangers and springs, which rest on cast steel seats formed upon the frames of the motors. The flexible jointing of the motor frame and its independence of the truck permit of easy riding of each motor upon its springs. The engravings show how the truck frame proper, to which the brake rigging is attached, may be lifted off entire, leaving the wheels and motors upon the track. To do this it is merely necessary to take out the pedestal cap bolts. The brake rigging is hung between the wheels and is of the fewest possible number of parts, without rods or levers over the motors. With this arrangement the tendency for the truck frames to tilt upon the application to the brakes is reduced, this being particularly desirable in the service for which these trucks are intended.

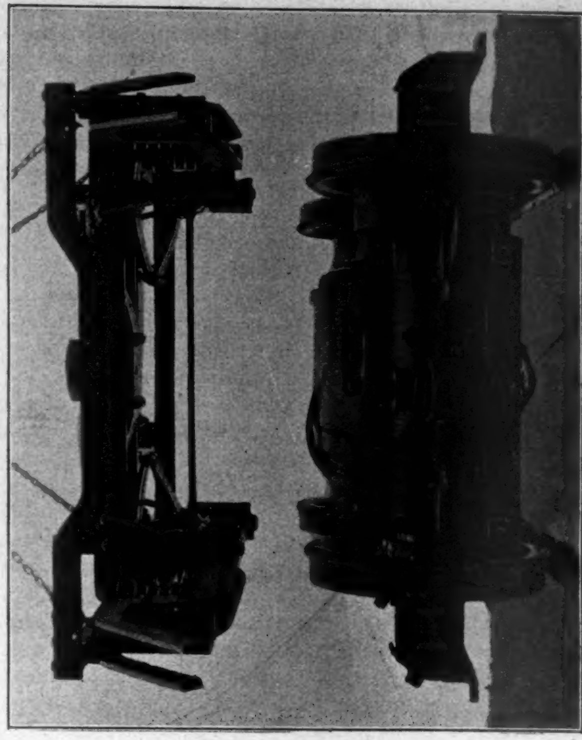
With a wheel base of six feet there is room enough to apply two 100-horse-power single reduction motors to these trucks. Wherever possible the weight of the parts has been kept down without sacrificing strength and wearing qualities. Renewable wearing surfaces are provided between the bolster and transom and the pedestals and transoms are lipped over the frames in order to cut down the shearing stresses on the bolts. The arrangement of springs is that which is in common use in passenger equipment. The equalizer springs are single coils, the bolster springs are double elliptic and the motor suspension springs have single coils. The transom is in the form of a light iron forging, similar to a locomotive truck, and made in one piece. It is lipped over the side frames and has chafing plates to receive the wear of the bolster. Cast iron driving boxes are used, with bronze bearings, similar to those used in engine trucks. The weight of the truck, not including motors but complete in other respects, is about 10,000 pounds.

These trucks are fitted with brake slack adjusters and they appear to be specially well adapted to the intended service. We consider the motor suspension, the accessibility, the strength and the way in which the truck frame may be removed from the other gear the most important features. There is every reason to expect that they will ride well, and it is evident that the designer has made very effective use of his experience in locomotive and car design.

In order to be able to meet the unprecedented demand for freight cars, the Pennsylvania Railroad has decided to order 2,000 more box cars, the contract to be placed with a Western concern. The statement is made by an official of the railroad company that within the past six months, 11,800 new cars have been ordered and put into service, and still the company is unable to take care of its patrons. The tonnage of the Pennsylvania already shows a 20 per cent. increase over that of the corresponding period of 1898.



Side View, with Truck Frame Lifted Off.



End View, with Truck Frame Lifted Off.

Perspective Views of Truck Complete.

NEW BALDWIN-WESTINGHOUSE MOTOR TRUCK.

Designed by Mr. Geo. Gibbs, *Consulting Engineer of the Baldwin and Westinghouse Companies.*

Built by The Baldwin Locomotive Works.

(Established 1832)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

J. S. BONSALL, Business Manager.

MORSE BUILDING....................................NEW YORK

G. M. BASFORD, Editor.

E. E. SILK, Associate Editor.

NOVEMBER, 1899.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post-Office Order. Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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Extended piston rods appear to be regarded with increasing favor, particularly on roads with mountain grades, which necessitate a large amount of drifting with the throttle closed. In this issue Mr. J. G. Beaumont, Superintendent of Motive Power of the Southern Railway of Peru, expresses his opinion positively in their favor. In the United States many follow this practice on large cylinders, but Mr. Beaumont goes so far as to use extended rods on very small cylinders. His experience seems to justify the opinion that the practice is a good one for all locomotives.

The value and advantage of using silica in connection with graphite in making a strong and durable paint for the protection of steel and iron are outlined in a communication from the Jos. Dixon Crucible Company, printed on another page of this issue. This letter was called forth by a paragraph on page 333 of our October issue, being a brief report of opinions expressed at the recent convention of the Master Car and Locomotive Painters' Association, to the effect that silica was considered an adulterant of graphite paint. The manufacturers wish it to be understood that silica is used purposely and for the improvement of the paint. "It is to the graphite what alloy is to gold." It improves the wearing qualities. The letter suggests that the speakers meant silicate of alumina (clay) instead of silica. This was probably the case.

At present we are enjoying "good times." Every line of industry is fully employed and the difficulty is to secure enough skilled men to carry out the orders which are pouring in from every direction. With the flush of success there comes a danger. Good times alternate with panics and they will probably always continue to do so. A question which should have earnest attention just now is how to postpone the end of the present activity. This is admirably answered in a thoughtful, sensible editorial in "Engineering News" of September 28, which emphasizes the necessity for caution against engaging in large schemes which contribute to the further rise of prices and contribute directly toward hastening the time of trouble. We quote from the article: "It is the best possible time to pay debts and not to incur them. . . . Is it not a fact that our seasons of financial prosperity and adversity are really due to fluctuations in the tide of demand? Do we not need as much to check it in times of prosperity as to stimulate it in times of adversity? Must we not, in fact, do the one in order to do the other?" These are good suggestions to ponder over. This writer goes on to say: "It is a better time to pay debts than to buy steel rails, or bridges or rolling-stock, except in so far as these may be absolutely necessary for the profitable operation of the road. Every company which pursues this policy is not only saving money for its stockholders but is helping to prolong good times and diminish the shock of financial disaster when it comes. Its orders which would now be booked at high prices and with long delays, will be eagerly sought for at some future day, and will serve to keep some mill going that would otherwise stand idle. . . . The way to make the good times stay, then, is simply to hold in reserve a part of the forces which are now pushing the tide of prosperity on toward its flood, that they may be expended later to check the ebb, and leave at least enough water in the harbor that not so many good ships may become stranded." This is the day of large enterprises and the temptations are great, but the dangers are also great and the day of reckoning certain. Those who are wise will heed such a common sense warning so admirably expressed.

GAS ENGINES FOR SHOP DRIVING.

The rapid and substantial advancement of the gas engine as a power producer for machine and generator driving will surprise those who examine its present status with a view of using it to replace steam. By many who are not informed as to its progress it is regarded as too experimental and too uncertain for consideration as a source of power for running machines which must work every day and must not be stopped for breakdowns. The gas engine is very far from perfect, but it has now reached a stage which warrants its consideration as a reliable motor which is cheaper than the steam engine in fuel cost and attendance, and in addition to these advantages it offers a means for subdivision of power that is equal in efficiency, if not superior to that of electricity.

The reliability of the internal combustion engine is proven by those that are running all day long without stopping and many are running in buildings which are closed and locked except when the attendant comes to oil them. A 65 horse-power Westinghouse gas engine has made a wonderful record for long continuous running, which has probably not been approached in severity by any steam engine running in regular service. The one referred to is in New York City, and from Oct. 15, 1898, to Feb. 28, 1899, it averaged 22.3 hours running per day for 137 days. During this time it was idle but 230 hours and

only 49 of these were required in repairs to the engine. We are told that 26 hours were spent in replacing the igniters with new ones, and 12 hours were given to the bearings and adjustment of other parts. A continuous run of 638 hours, ending Feb. 19, is recorded. It is not necessary to say more with regard to reliability, because that engine was working under conditions more exacting than are usually confronted by steam engines.

The gas producer furnishes means for operating gas engines independently of city mains and oil or distillate may be used where it is difficult to secure appropriations for the gas plant. The attendance required for a gas producer is less than for a boiler, because the operations are almost entirely automatic. Mr. A. R. Bellamy* gives valuable records from the daily operation of a plant in England, including two 40 horse-power gas engines driven by producer gas. Two-thirds of a cent per indicated horse-power hour cover all charges for operation, where anthracite coal costs $6.25 per ton. The producer makes 1,000 cubic feet of gas from 14 pounds of coal, including all losses, and the two engines, the producer and a steam boiler (for operating steam hammers), were attended by one laborer. The same expense for attendance would be ample for double this amount of power. The engines in this case are looked after by an uneducated man, who gives them less than two hours per day. The cost of the gas may be placed at 6½ cents per 1,000 cubic feet. The consumption of fuel is 0.939 pound per indicated horse-power per hour, including all losses, and against this may be placed the wasteful single expansion steam engine with disgracefully long steam pipes. It is well known that many such engines have been struggling for years at an expense of from five to eight pounds of coal per indicated horse-power hour. Mr. Bellamy records valuable figures for electric lighting. The power used in the case cited is 18 brake horse-power. At 83 cubic feet of fuel gas per brake horse-power hour and an average of 20 hours per week, the cost was less than 10 cents per hour for 38,000 candle power in arc lamps and 496 candle power in incandescents. The efficiency attained by the Westinghouse gas engine, as reported by Mr. Edwin Ruud†, for engines of 20 horse-power and upward with natural gas is from 10.5 to 12 cubic feet per brake horse-power hour and a special 125 horse-power engine has given the phenomenal economy of one brake horse-power for 9 cubic feet. This gas gives 1,000 British thermal units per cubic foot and the best record is an efficiency of 28.7 per cent., while 33 1/3 per cent. is promised for every day performance.

The figures for the operation of oil engines, including all charges, are not available for comparison, but we have Professor Denton's authority, based on a test of a 20 horse-power Diesel motor, expressed in his report as follows: "As the motor shows itself to be able to use oil obtainable at about two cents per gallon, the cost of a brake horse-power may be two-tenths of a cent per hour, which is slightly less than the cost of the same power from the average triple-expansion steam engine, with coal at $3 per gross ton."

The proposition before a shop manager who is planning improvements or entirely new shops, is this: Will it be a good investment to install a gas engine equipment for the entire power plant, put in a gas producer and also provide a steam plant for heating in the winter? The man who does this may be considered bold, but he has excellent precedents and will undoubtedly save money by it. The gas producer may be run when needed, and by providing sufficient storage no gas need be made when only a part of the engine equipment is running. This simplifies night work. The subdivision of power by gas engines is easy and economical and gas fuel may be distributed much more easily than power. Quoting Mr. Bellamy again: "One horse-power at the gas plant is sufficient to force through mains one mile long, sufficient to supply 3,000 horse-power. It is probable that in certain cases it will be cheaper to run small outlying shops of a large plant by gas engines than to drive by electric motors from a steam driven generator."

A little study of existing records reveals a most promising prospect for the internal combustion engine, whether the fuel is oil or producer gas, and the outlook for producer gas made from the cheapest forms of anthracite, down to the size known as buckwheat, is exceedingly bright. The illustrated description of the producer and gas engine plant at the Jersey City Terminal of the Erie R. R. in this issue is worthy of thoughtful attention in this connection.

* Paper read before the Manchester Association of Engineers.
† In a paper read before the Technical Society of Pittsburgh.

LOCOMOTIVE FRONT ENDS.

The wide differences of opinion of motive power officers with regard to the arrangement of details of devices which are intended to carry out the same purpose is nowhere better illustrated than in the construction of locomotive smokeboxes. While there are several types of front end arrangements, there is practically no uniformity and no agreement as to which of a large number of designs is the best. Almost every individual road has its own design, and sometimes there are great differences in the practice of different parts of the same road in this particular.

The most satisfactory work on the front end problem was that of the committee on smokestacks and exhaust nozzles reporting to the Master Mechanics' Association in 1896, but even since that effort to improve the design of these parts we find that there are still as wide differences of opinion as before, and while the committee recommendations have often been very successful it is found that some roads have made utter failures in attempts to use them. The chaotic condition of practice in this respect is noteworthy because of the important effects of a satisfactory front end upon the economy of fuel. It does not seem sufficient to say that this variety is due to different qualities of fuel, and it is difficult to believe that each of the different designers has secured the best arrangement.

The history of this subject and its present state of development in this country are admirably presented in an exceedingly able paper by Mr. J. Snowden Bell recently read before the Western Railway Club. This paper and one presented by Mr. Willis C. Squire, before the same organization in November, 1893, contain a very satisfactory record of what has been done in this direction. Mr. Bell has made an elaborate study of the draft requirements and spark-arresting features of locomotives and sums up his opinions in the following conclusions:

1. That a smokebox of greater length than is necessary to permit the use of a sufficient area of netting to provide for free steaming, is not only useless but also positively prejudicial, as to the steaming of the engine and economy of fuel.
2. That, particularly with boilers of the present average diameter, the length from center of exhaust pot to front should not exceed, say, thirty-five inches, and that all necessary netting and draft appliances can be properly applied in a smokebox of such length.
3. That the front end should be of what is known as the "self-cleaning" type, and that the cinder pot or cinder hopper is wholly useless and a needless addition to the cost of the engine.
4. That where an open stack is employed, the taper or "choke" pattern will, if properly designed and proportioned, be more usefully and economically effective than a "straight" or cylindrical stack.
5. That the construction recommended by the American Master Mechanics' Association at its 1894 and 1896 conventions, embodies, as a whole, the most desirable and effective plan or design, under the general principles and conditions applicable to and controlling in locomotive front ends.
6. That, under certain conditions, the design of front end embodying a short smokebox, a diamond stack, low exhaust pot, and lift pipe, is as usefully and effectively applicable as that of the Master Mechanics' Association.
7. That the useful and economical effect of a locomotive front end is wholly and solely dependent upon the draft appliances and spark arresting devices employed, and that such effect will be reduced proportionately to any increase of smokebox length beyond that necessary for the application of said appliances and devices.
8. That experimental research can be advantageously made in the directions of: (a) ascertaining what reduction of smokebox length is practicable; and (b) whether or not an appliance can be produced whereby cinders may be returned to the firebox in a practically useful manner.

The ideal front end arrangement is one which will give the

desired draft upon the fire and prevent sparks and fine dirt or dust from being blown out of the stack. There are differences of opinion in regard to the best disposition of the matter which is drawn through the tubes by the draft, Mr. Bell holding that the front ends should be made self-cleaning in such a way that dirt and cinders will not collect there, but that they shall be ground up and passed out of the stack in such a finely divided form as to avoid setting fires. Many agree with him in this, and a number of plans have been devised and are in successful use accomplishing this purpose. Others believe that the sparks should be retained in the front end and be removed at the end of the run in order to throw the least possible amount of dirt over the train. This opinion had able support in the discussion of Mr. Bell's paper from such men as Messrs. A. E. Manchester, J. F. Deems, F. A. Delano and G. R. Henderson.

In commenting upon some of the details of this problem in the December, 1898, issue of this paper, page 394, the following opinion was expressed.

"The front end problem is based upon the shortcomings of other parts of the locomotive, and the best way to solve it, and the only way to completely settle it, is to keep the sparks in the firebox and burn them there. In order to accomplish this, the firebox, grates and heating surface must be considered, as well as the front end. The fuel losses from sparks are not to be neglected, and it is not sufficient to merely provide for getting rid of them after they leave the firebox. Professor Goss has shown (American Engineer, October, 1896, page 255) that popular judgment in considering spark losses to be small is entirely wrong. Under ordinary working conditions in common practice they may amount to more than 10 per cent of the fuel value of the coal."

It is undoubtedly worth while to carefully study the causes which result in the production of sparks, the chief of which is the strong draft which is so commonly required. The most important conclusion reached in this discussion, and one which will probably become fruitful is such an increase of grate area as will enable the fuel to be kept in the firebox instead of being pulled through the tubes unconsumed by the powerful draft, which is necessitated by a small grate area. It is clear that the question is much deeper than has generally been considered, and that the fire needs as much, if not more, attention than the spark-arresting features.

Mr. William Forsyth's arguments for large grates, which appear elsewhere in this issue, are heartily commended in this connection, and it is believed that if his suggestion as to adapting the width of the firebox to the special conditions in each design of locomotive the front end difficulties will be greatly simplified.

Another phase of this question which did not receive attention in the discussion referred to is the effect of the reduction in height of the smokestacks of large locomotives. That this is an important feature of front-end design is now thoroughly appreciated by those who are increasing the size of locomotives and the influence of this fact seems likely to result in a reversion of opinion in regard to the use of draft pipes. A description of the front end arrangement of a large passenger locomotive, given in this issue, is interesting in this connection. Several well-informed men believe that this is the coming plan.

The Directors of the Wagner Palace Car Company have made an agreement with those of the Pullman Car Company, subject to ratification by the shareholders of both companies, for the sale of all the assets and property to the Pullman Company. The price per share of the Wagner stock is $180 in cash, or it will be exchanged share for share of the Pullman stock, and the latter stock is to be increased by 200,000 shares. The action of the Wagner Directors was unanimous and they have elected to take stock in exchange for their holdings. If the action of the Directors is ratified the Wagner Company will be dissolved at the end of this year. This means the end of competition in the operation of sleeping cars on the railroads of this country, because it is not at all a promising field for a new company to attempt to enter against the strength of the two sleeping car companies combined in one concern.

CORRESPONDENCE.

SILICA IN GRAPHITE PAINT.

Editor "American Engineer and Railroad Journal:"

We find the following paragraph on page 333 of the October number of the "American Engineer and Railroad Journal":

"For protective coatings for iron and steel, the Master Car and Locomotive Painters' Associations, in their recent convention, expressed preferences for oxide of iron, graphite and carbon pigment. Pure graphite was considered excellent, but this paint was liable to be adulterated with silica, which, while being a good filler, did not give good wearing qualities."

Kindly permit us to have something to say on this subject. There was, at that convention, undoubtedly considerable misunderstanding as to the nature of graphite; and in fact the nature of graphite, or rather, the varying nature of graphite, is not fully understood. The Dixon company make a silica-graphite paint, and advertise it as such; therefore the graphite cannot be said to be adulterated with silica, as the silica is put in with intent and for a purpose.

We note in the paragraph quoted, that "silica, while being a good filler, does not give good wearing qualities." We regret that no mention was made as to why the silica is not possessed of good wearing qualities. The man or men who gave voice to this statement most certainly did not understand the nature of graphite and the nature of silica. Silica is almost as refractory as graphite; it is attacked only by strong alkalies. We think, therefore, that very likely the speaker had in mind silicate of alumina or, in other and plain words, clay.

As mentioned above, the Dixon company are manufacturers of a silica-graphite paint. The graphite is the Ticonderoga graphite, chosen because of its flake formation, and because of its hardness and toughness. Ticonderoga graphite will outwear Ceylon graphite or any other form of graphite with which we are familiar, and we buy and sell all kinds.

The silica is added not only because it is a most excellent filler, but because it strengthens and hardens the coating, so that the coating of paint will better resist the wear and tear of storms of all kinds, and friction generally. It is to the graphite what the alloy is to the gold in a watch chain. Without it the wear is rapid.

A silica paint is made and sold quite extensively in England, but it is known to be a brittle paint. Graphite, especially flake graphite, forms an exceedingly elastic coating. Graphite paint with silica makes, all things considered, just as near an ideal protective coating as science and practice have been able to find.

JOS. DIXON CRUCIBLE CO.

Jersey City, October 9, 1899.

FAVORABLE OPINION OF EXTENDED PISTON RODS.

Editor The "American Engineer and Railroad Journal."

In the August number of your important paper I have read an article on extended piston rods, in which an account is given of the discussion on this topic at the Master Mechanics' convention. Having had an experience of nearly ten years in this matter, I should like to make known my views on this subject.

We have found the use of tail rods so satisfactory that we have fitted almost all our engines with them, using them with all sizes of cylinders, from 7⅝ inches to 20 inches.

As this is a mountain railway, our engines do almost 50 per cent of their mileage, drifting, and formerly we experienced continual trouble on account of cylinders wearing badly in the front on the lower side, which compelled us to re-bore them frequently; but since we adopted the extended piston rods, we scarcely ever have to re-bore a cylinder. I believe that anybody who gives extended piston rods a trial, will use them ever afterwards. Our practice is to pass the extended rod through the front cylinder head by a stuffing-box and gland. In this arrangement there is of course no difficulty to lubricate the rod. On the gland we generally bolt a piece of thin piping with a flange to act as a sleeve and protect the tail rod from the cold air, when it is outside of the cylinder.

I have never had any experience with the working of tail rods forming a part of the volume of the cylinder, but I believe that the resulting increased clearance will certainly cause waste of steam. An incidental advantage of the extended rods, of which we avail ourselves, is that they facilitate the lining

of the guide bars. We make the front and back glands with a nice fit, which keeps the piston rod perfectly in line with the cylinder; we key the crosshead to the piston rod, and then adjust the guides by the crosshead. If the guides are rightly set, the back gland will move easily in the stuffing-box at any point of the stroke. I believe that it will be difficult to surpass the simplicity of this method.

We have lately rebuilt in our shops at this city eight engines of the ten-wheel type which are fitted with extended piston rods. One of these was fully described and illustrated in London "Engineering," of May 26th last.

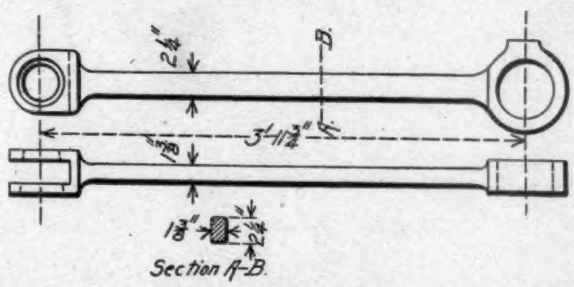
J. G. BEAUMONT,
Superintendent Motive Power and Machinery.
Southern Railway of Peru,
Member American Railway Master Mechanics' Association.
Arequipa, Peru,
September 1, 1899.

SECTION OF SIDE RODS.

Editor The "American Engineer and Railroad Journal."

I have read with much interest the valuable contributions on locomotive design by Mr. F. J. Cole of the Rogers Locomotive Works in several numbers of your journal, and have frequently had opportunity to compare them with our own practice, with satisfactory results. The other day, however, a broken side rod came to my notice, the proportions of which were a little different from the customary, and with your permission I would like to call Mr. Cole's attention to the same through the columns of your paper.

In 1887 we prepared designs for a lot of consolidation engines of the then prevailing size, 20x24 inch cylinders, 50-inch driving wheels and 140 lbs. boiler pressure. In calculating the dimensions for the side rods I was guided principally by the method described by Prof. Reuleaux in the third edition of "Der Konstructeur," except that I made the parallel rods of a constant



section instead of tapering toward the ends. The dimensions thus obtained seemed sufficient to prevent excessive fibre stress due to centrifugal force, and the resistance to buckling appeared to correspond to that of the piston rod in proportion to the length.

The first set of rods made according to this design was put on a locomotive in May, 1888. When this engine, the 328, was ready to leave the shop, the general opinion among the shop people was that the rods would break before the engine got to the round house. In point of fact these rods were so strongly criticised by everybody who saw them, that I received orders the same day to change the design to dimensions corresponding to side rods of other engines of similar type in use elsewhere at that time. I attach herewith a sketch giving the principal dimensions of the back parallel rod on the first engine. The cross section measures 3 square inches. The rods were made of iron. The new cross section of the corresponding rod on the other engines of the lot was 1½x3½ inches, equal to 4¼ square inches of iron.

The incident passed out of my mind until a few days ago, when we received report of a broken side rod on engine 328. On investigation we found that it was the back rod, and that it had broken by accident while the engine was being put back on the track after a derailment. This was the first failure of any of the rods on this engine during a hard service of 11½ years. For this reason I felt tempted to believe that the fibre stress usually permitted in locomotive side rods might be increased without risk. Still I consider Mr. Cole's figures more in accordance with modern practice, and not at all unreasonable.

EDWARD GRAFSTROM.
Office of Superintendent of Motive Power,
Pennsylvania Lines West of Pittsburgh.
October 3, 1899.

LOCOMOTIVE DESIGN.*

By F. J. Cole, Mechanical Engineer, Rogers Locomotive Works.

Riveted Seams.

Riveted seams must necessarily be weaker than the solid plate, and due allowance should be made for the loss of strength caused by cutting away the plate for the rivet holes.

The strength of boiler seams compared to the solid plates may be taken, approximately, at 55 to 60 per cent. for single riveted lap seams, 70 to 75 per cent. for double riveted lap seams, and 82 to 87 per cent. for butt seams, with quadruple or sextuple riveted double cover strips. The rivets should be spaced as far apart as the thickness of the sheets and a tightly calked joint will permit. In single riveted seams, Fig. 1, failures may occur in three ways: (a) tearing the plate between the rivet holes, (b) shearing the rivets, (c) tearing out the plate in front of the rivet holes.

In double riveted lap seams, Fig. 2, failures may occur in three ways: (a) tearing the plate between the rivet holes, (b) shearing all the rivets, (c) tearing out the plate in front of one row of rivet holes and shearing the other row of rivets.

In butt seams with double cover strips of unequal width, Fig. 3, failures may occur in four ways: (a) tearing the plate through the outer rivet holes along the line A B, (b) tearing the plate through the rivet holes on the line C D, and shearing off the outer row of rivets on the line A B, (c) tearing out the outside cover plate in front of the rivets and shearing the rivets in the outer row A B, (d) shearing all the rivets.

The resistance of rivet iron to single shearing is usually assumed to be about 38,000 pounds per square inch of section, and from 1.7 to twice that amount in double shear. Numerous tests made at the Watertown Arsenal and by other reliable investigators, could be cited to confirm the accuracy of the generally accepted strength of rivet iron in single shear at the above mentioned figure.

In a well proportioned lap joint the net strength of the plates between the holes or the crushing strength in front of the rivets should equal the shearing strength of the rivets. As the plate is subject to greater deteriorating influences, such as pitting, grooving, and other forms of corrosion, cracking, bending, etc., the strength should be in favor of the plate, rather than of the rivets.

Let t = thickness of plate.
d = diameter of driven rivet (i. e., rivet hole).
n = number of rivets in section.
P = pitch of rivets.
S = tensile strength of plate per square inch.
R = shearing strength of iron rivets = 38,000 lbs.

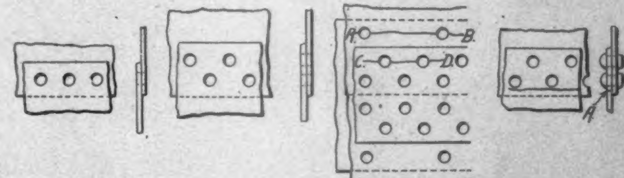


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Then:

$$\frac{P-d}{P} = \text{percentage of solid plate,}$$

$$\frac{(P-d)\,St}{P} = \text{strength of plate per inch of width,}$$

$$\frac{n\,R\,(d^2\,.7854)}{P} = \text{strength of rivets per inch of width.}$$

The simplest way to determine the strength of butt seams with cover strips of unequal width, is to take a section equal to the pitch of the outside rivets and estimate the strength

* For previous article see page 292.

of the rivets and plate in that section. Afterwards if desired the figures may be divided by the maximum pitch for the strength per inch of width.

Example:

Steel plate ⅝ inch thick, sextuple riveted butt seam, 1⅛ inches diameter iron rivets, hole 1 3/16 inches, pitch 4 inches inner row, 8 inches outer row. Fig. 3,

Plate 55,000 lbs. ultimate strength per square inch.
" 34,375 lbs. per square inch wide, ⅝ inch thick.
1 rivet $1\frac{3}{16}$ inches diameter line A B = 42,085 lbs.
Plate, line A B = $(8 - 1\frac{3}{16})$ 34,375 = 234,179 lbs.
Plate, line C D = $2 \times (4 - 1\frac{3}{16})$ 34,375 = 193,350 lbs.
Solid plate, 8 × 34,375 = 275,000 lbs.
Combined stre gth to shear rivet on line A B and to tear plate on line C D = 42,085 + 193,350 = 235,435 lbs.

Percentage of solid plate, $\frac{234,179}{275,000} = 85.2.$

The friction between the plates should not be considered in calculations of riveted seams. Holes may be punched without material injury to the plates, provided they are afterwards reamed out, preferably after the plates are assembled together. The rivet holes should be slightly countersunk on the outside. This not only makes the rivet head stronger, but reduces the number which require calking, as the fillet forms a steam tight joint around the holes. The margin from the center of the rivet to the outside of the plate is usually taken at 1½ times the diameter of the rivet, 1.5d.

A riveted joint is well proportioned when the shearing strength of the rivets is equal to the tearing or tensile strength of the plate between the rivet holes, provided the rivets are of suitable diameter and pitch to suit the thickness of the plates. If a section of the joint in question be pulled apart in a testing machine, it should fail at about the same stress by the tearing apart of one of the plates between the holes or by the shearing of the rivets. Butt joints with inside cover strips wider than the outside may, however, fail by a combination of tearing and shearing.

It is evident that to obtain the highest percentage of strength in a riveted joint, the least amount of metal should be cut away for the rivet holes on any given line. It therefore follows that as the area of a solid circular body, such as a rivet, increases according to the square of its diameter, while the holes in the plate weaken it only in proportion to their diameter, or that the strength of the plate depends entirely upon the amount that is cut away by the holes in any given direction, the best results are obtained when the pitch of the rivets is limited only by the stiffness of the plate to withstand the tendency to force them apart in calking. The tightness and stanchness of the joint is therefore the limiting factor, in the pitch and diameter of the rivets used for joining together plates of moderate thickness, with the ordinary forms of single and double lap joints.

The sizes of rivets used in locomotive boilers range from ⅝ inch to 1¼ inches in diameter, and the holes or the size of the rivet after it is driven from 11/16 inch to 1 5/16 inches. The diameters before driving vary by eighths of an inch, as follows: ⅝, ¾, ⅞, 1, 1⅛ and 1¼—the intermediate sizes in sixteenths being seldom used. Although much greater theoretical uniformity in joints may be made when the shearing of the rivets and the tearing of the plates nearly equal each other, yet in practice it is more convenient not to use the intermediate diameters, but allow a greater variation of strength between the plate and the rivets. It is rarely that the 1¼ inch diameter rivet is exceeded. The great pressures required to make the metal flow properly and fill the holes, render it better practice with ordinary facilities to use triple riveted lap joints for the circumferential seams and sextuple butt joints for the longitudinal seams of unusually large boilers. In view of these limitations the proportions of riveted joints are usually modified to suit the actual rather than the theoretical conditions, the diameters of rivets used being determined largely by the practical considerations involved in their driving.

The proportions of riveted joints are usually taken from tables which have been worked out and carefully prepared to suit the facilities and requirements of different establishments or railroads. A much greater uniformity may thus be obtained than by calculating the joints as required. The pitch, number and diameter of the rivets are thus determined once for all to suit the various thicknesses of plates and style of joints to give uniformity between the strength of the rivets, and to obtain the highest percentage compared to the solid or unperforated plate.

Lap joints should never be used for the longitudinal seams of the cylindrical portion of the boilers, especially where the plates exceed ⅜ inch in thickness. Any style of lap joint, whether reinforced with welts, strips, or other forms of strengthening plates, necessarily pulls obliquely and requires a departure from a circular shape, giving rise to unequal strains. Any movement, vibration, or bending caused by the pressure not being equal at all parts of the circumference is liable to be concentrated at a lap joint, and owing to the pull not being in line with the sheets may in time cause a crack to start. Several explosions due to this cause came under the writer's personal observation. The cracks, A, Fig. 4, always started from the inside, extending in one case 30 inches long, and at the time of failure ⅛ inch only was left of the solid metal. Butt joints do not require the sheets to be distorted, but enable the plates to be joined together without altering the circular form at any point, or having any tendency to pull obliquely at the joint.

No precise rule can be laid down for the diameter of the rivets to suit the different forms of joints. In a general way, for punched holes, the diameter of rivets should not be much less than 1½ times the thickness of the plates. Unwin gives the rule:

$$d = 1.2 \sqrt{t}$$

where d = diameter of rivet before driving.
t = thickness of plate.

The following table is taken from the same source, based upon the above formula:

DIAMETERS OF RIVETS FOR DIFFERENT THICKNESSES OF PLATES.

Thickness of plate, t.	Diameter of rivets, d.		Diameter of rivets after riveting, 1.04 d.
¼	0.60	9/16	0.59
5/16	0 67	11/16	0.72
⅜	0.73	¾	0 78
7/16	0 79	13/16	0.85
½	0.85	⅞	0.91
9/16	0.90	⅞	0.91
⅝	0.95	15/16	0.97
¾	1.04	1 1/16	1.10
⅞	1.12	1⅛	1.17
1	1.20	1 3/16	1.24

SHEARING STRENGTH OF RIVET IRON ASSUMED TO BE 38,000 POUNDS PER SQUARE INCH.

Driven Size. Inch.	Area.	1 Rivet.	2 Rivets.	3 Rivets.	4 Rivets.	5 Rivets.
9/16	2485	9.443	18,886	28,329	37,772	47,215
⅝	.3068	11,658	23,316	34,974	46,632	58,290
11/16	.3712	14.106	28,212	42,318	56.424	70,530
¾	.4418	16,788	33,576	50,364	67,152	83,940
13/16	.5185	19,703	39,406	59,109	78,812	98,515
⅞	.6 13	22,849	45,698	68,547	91,396	114,245
15/16	.6903	26,231	52,462	78,693	104,924	131,155
1	.7854	29,845	59,690	89,535	119,380	149,225
1 1/16	.8866	33,691	67,382	101,073	134,764	168,455
1⅛	9940	37,772	75,544	113,316	151,088	188,860
1 3/16	1.1075	42,085	84,170	126,255	168,340	210,425
1¼	1.2272	46.634	93,268	139,902	186,536	233,170
1 5/16	1 3530	51,411	102,828	154,242	205,656	257,070
1⅜	1.4849	56,426	112,852	169,278	225,704	282,130
1 7/16	1.6230	61,674	123,348	185,022	246,896	308.370
1½	1.7671	57,150	134,300	201,450	268,600	335,750

This table is taken in part from the Report of the Committee on Riveted Joints, American Railway Master Mechanics' Association, Proceedings of 1895, page 217.

FIG. 5.—SINGLE RIVETED LAP SEAM.

Thickness of sheet.	Diameter of rivets.	Diameter of rivet hole.	A	B	C	Per cent. of solid plate.
1/4	5/8	11/16	1 7/8	1	2	63
5/16	3/4	13/16	2	1 3/16	2 3/8	59
3/8	3/4	13/16	2	1 3/16	2 3/8	59
7/16	7/8	15/16	2 1/8	1 5/16	2 3/4	56
1/2	1	1 1/16	2 3/8	1 7/16	3 1/8	55
9/16	1	1 1/16	2 3/8	1 7/16	3 1/8	55
5/8	1 1/8	1 3/16	2 1/2	1 3/4	3 1/2	52
11/16	1 1/8	1 3/16	2 1/2	1 3/4	3 1/2	52
3/4	1 1/4	1 5/16	2 5/8	1 7/8	3 3/4	50

FIG. 6.—DOUBLE RIVETED LAP SEAM.

Thickness of sheet.	Diameter of rivet.	Diameter of rivet hole.	D	E	F	G	Per cent. of solid plate.
1/4	5/8	11/16	3	1 5/8	3 5/8	1	76
5/16	3/4	13/16	3 1/8	1 5/8	4	1 3/16	74
3/8	7/8	15/16	3 1/4	1 3/4	4 1/2	1 5/16	71
7/16	7/8	15/16	3 1/4	1 3/4	4 1/2	1 5/16	71
1/2	1	1 1/16	3 1/2	1 7/8	5	1 7/16	70
9/16	1	1 1/16	3 1/2	1 7/8	5	1 7/16	69
5/8	1 1/8	1 3/16	3 3/4	2	5 1/2	1 3/4	68
11/16	1 1/8	1 3/16	3 3/4	2	5 1/2	1 3/4	67
3/4	1 1/4	1 5/16	3 3/4	2	5 3/4	1 7/8	65
13/16	1 1/4	1 5/16	3 3/4	2	5 3/4	1 7/8	65
7/8	1 1/4	1 5/16	3 3/4	2	5 3/4	1 7/8	65
15/16	1 3/8	1 7/16	3 3/4	2	6 1/4	2 1/8	62
1	1 3/8	1 7/16	3 3/4	2	6 1/4	2 1/8	61

Double riveted lap seams are not suitable for plates exceeding 7/8 inch in thickness, when rivets driven in $1\frac{5}{16}$ holes are used. In order to preserve the uniformity existing between the tearing or strength of the plate between the rivet holes and the shearing of the rivets, the diameter of the rivets must be increased after the thickness exceeds 7/8 inch. Triple riveted seams are more suitable for the circumferential seams of plates over 7/8 inch thick.

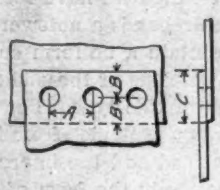


Fig. 5.

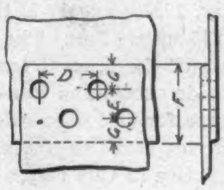


Fig. 6.

FIG. 7.—QUADRUPLE RIVETED BUTT SEAMS.

Thickness of sheet. in.	Diameter of rivet. in.	Diameter of rivet hole. in.	H in.	I in.	J in.	K in.	L in.	M in.	N in.	Per cent of solid. plate.
1/4	5/8	11/16	1 7/8	2 1/4	1	4 1/4	8 1/4	3/16	1/4	81
5/16	5/8	11/16	2	2 3/8	1	4 3/8	8 5/8	3/16	1/4	83
3/8	3/4	13/16	2 1/8	2 1/2	1 1/8	4 3/4	9 1/4	1/4	5/16	81
7/16	3/4	13/16	2 1/4	2 5/8	1 1/8	4 7/8	9 5/8	5/16	3/8	82
1/2	3/4	13/16	2 3/8	2 3/4	1 1/8	5	9 1/2	3/8	3/8	81
9/16	7/8	15/16	2 1/2	2 7/8	1 3/16	5 1/2	10 3/4	3/8	7/16	77
5/8	1	1 1/16	2 5/8	3	1 1/2	6	12	3/8	7/16	78

FIG. 8.—SEXTUPLE RIVETED BUTT SEAMS.

Thickness of sheet. in.	Diameter of rivet. in.	Diameter of rivet hole. in.	P in.	Q in.	R in.	S in.	T in.	U in.	Per cent. of solid plate.
3/8	3/4	13/16	3 1/4	1 1/8	7 3/4	12 1/4	1/4	3/16	89
7/16	3/4	13/16	3 3/8	1 1/8	7 7/8	12 5/8	5/16	3/8	88
1/2	7/8	15/16	3 1/2	1 3/16	8 3/4	14	3/8	7/16	87
9/16	1	1 1/16	3 3/4	1 1/4	9 3/4	15 3/4	3/8	1/2	86
5/8	1 1/8	1 3/16	4	1 11/32	10 3/4	17 1/2	7/16	1/2	85
11/16	1 1/8	1 3/16	4 1/4	1 11/32	11	17 3/4	1/2	9/16	85
3/4	1 1/4	1 5/16	4 1/2	1 7/8	12	19 1/2	1/2	9/16	84
13/16	1 1/4	1 5/16	4 1/2	1 7/8	12	19 1/2	1/2	9/16	83
7/8	1 1/4	1 5/16	4 1/2	1 7/8	12	19 1/2	9/16	5/8	83
15/16	1 3/8	1 7/16	4 1/2	2 1/16	12 3/4	21	5/8	11/16	81
1	1 3/8	1 7/16	4 1/2	2 1/16	12 3/4	21	5/8	11/16	80

Firebox Seams.

For firebox seams the margin is made less than usual, the strength being a secondary matter to the tightness of the seam. A long lap is liable to burn, besides being more difficult to keep calked when exposed to the heat and flames of the fire. Fig. 10 shows the usual proportions for firebox seams.

FIG. 9.—BOILER RIVETS.

Diameter of rivet. inches.	Button Wide. A	Heads Thick. B	Cone Wide. C	Heads. Thick. E	Countersunk Wide. H	Heads Thick U.
1/2	7/8	3/8	7/8	11/32	7/8	1/4
9/16	15/16	3/8	31/32	21/64	15/16	9/32
5/8	1 1/16	7/16	1 1/16	9/32	1 1/8	9/32
11/16	1 1/8	1/2	1 1/8	33/64	1 3/16	5/16
3/4	1 1/4	9/16	1 1/4	21/64	1 1/4	3/8
7/8	1 7/16	3/4	1 7/16	3/4	1 3/8	7/16
1	1 5/8	3/4	1 5/8	27/32	1 5/8	1/2
1 1/8	1 3/4	13/16	1 27/32	15/16	1 7/8	9/16
1 1/4	2	1	2 1/16	1 1/32	2 1/8	5/8

The sizes of rivets are taken from Messrs. Hoopes & Townsend's catalogue, and represent the usual commercial dimensions of heads. The angle of the sides of heads for countersunk rivets is approximately 60 degrees, although the figures given range slightly from this angle in some of the sizes.

SHOULD BE (1/2 P)?

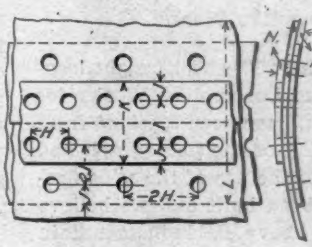


Fig. 7.

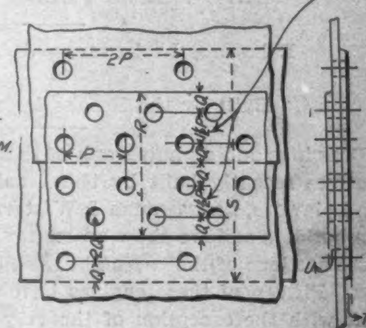


Fig. 8.

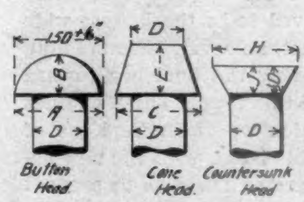


Fig. 9.

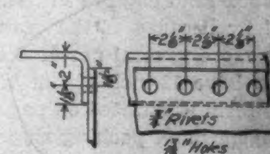


Fig. 10.

PROPORTIONS OF RIVET HEADS.

Button Heads.

Diameter head = 1 1/2 diameter shank + 1/8 inch.

Depth of head = 45/100 diameter of head.

Countersunk Heads.

Depth of head = 1/2 diameter of shank.

Bevel of head = 60 degrees (exactly).

Diameter of rivet.	Button heads. A	B	Countersunk heads H	J
3/8	11/16	5/16	11/16	3/16
1/2	7/8	13/32	15/16	1/4
5/8	1 1/16	15/32	1	5/16
3/4	1 1/4	9/16	1 3/16	3/8
7/8	1 7/16	21/32	1 3/8	7/16
1	1 5/8	3/4	1 9/16	1/2
1 1/8	1 13/16	13/16	1 25/32	9/16
1 1/4	2	29/32	1 31/32	5/8
1 3/8	2 3/16	1	2 3/16	11/16

The above table is adapted from the rivet proportions recommended by the Pencoyd Iron Works. The sizes represent heads of symmetrical proportions.

The proportions given for the various styles of seams represent what is known to be good practice. With good workmanship no trouble should be experienced in making perfectly tight work even with the wide pitches used for the thinner sheets.

Twelve-Wheel Freight Locomotive with Wide Firebox—D., L. & W. Ry.

J. W. FITZGIBBON, *Superintendent of Motive Power.* BROOKS LOCOMOTIVE WORKS, *Builders.*

TWELVE-WHEEL FREIGHT LOCOMOTIVES.

Delaware, Lackawanna & Western Railroad.

Built by the Brooks Locomotive Works.

Drawings and a photograph of the new 12-wheel freight locomotives recently built by the Brooks Locomotive Works for the Delaware, Lackawanna & Western, have been received from the builders and we show an engraving of the photograph and cross sections of the engine because of the use of the wide firebox. Fifteen of these engines have been built and we believe that with the exception of the very heavy Baldwin mountain pushing locomotives on the Lehigh Valley (American Engineer, December, 1898, page 395) these are the largest to be fitted with wide fireboxes. They are believed to be the largest wide firebox road engines in use. This fact, however, is interesting chiefly because of the example showing the tendency toward the more general use of fireboxes of this type. These engines also have 12-inch piston valves, which we understand are of the form illustrated on page 366 in this issue, with the new arrangement of packing rings, which are so made as to prevent the steam pressure from setting out the rings.

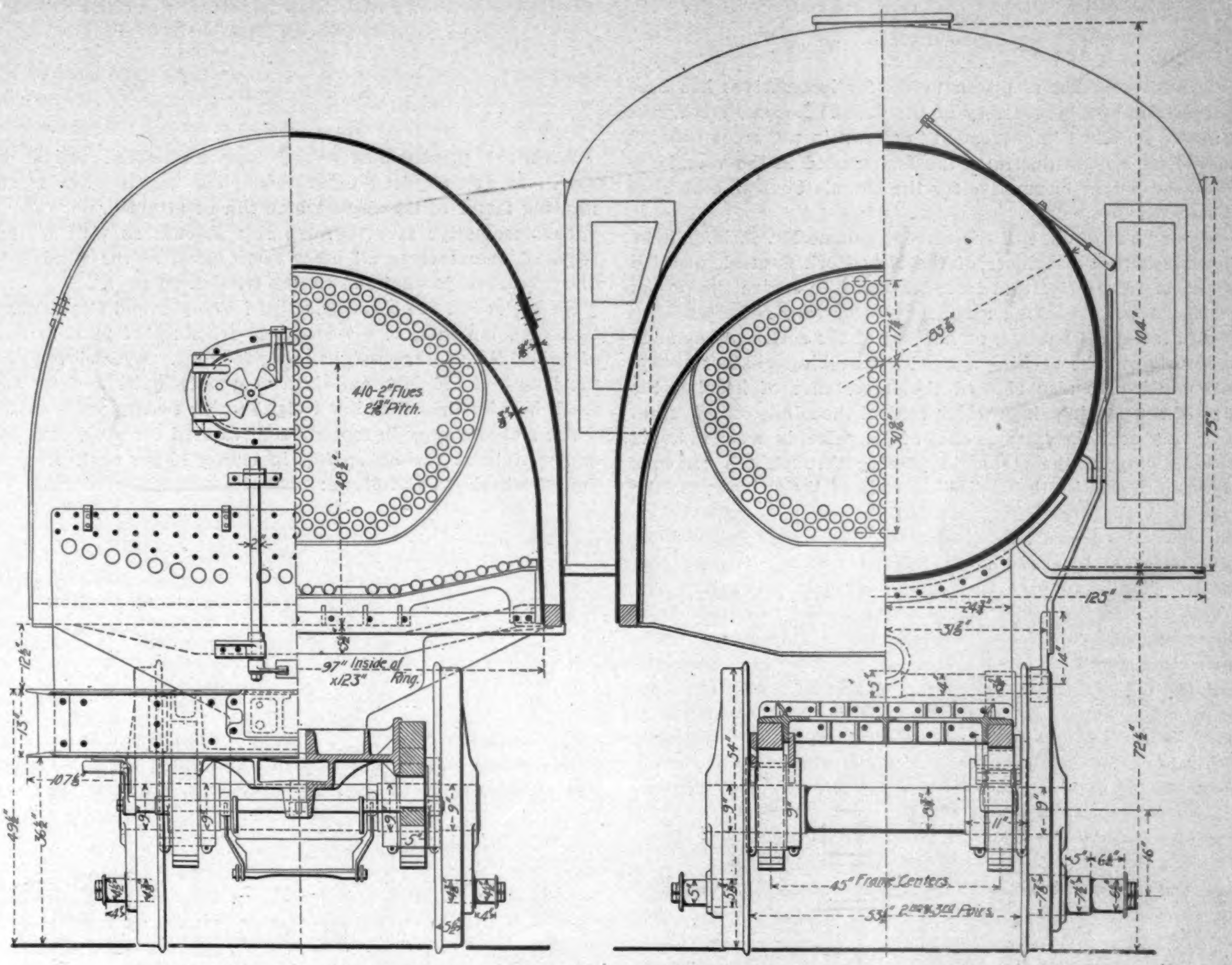
The total weight is 205,000 pounds, the weight on the drivers is 166,000 pounds, the cylinders are 21 by 32 inches and the driving wheels are 54 inches in diameter. With 200 pounds boiler pressure the tractive power will be about 47,000 pounds. Many of the details are similar to those of the heavy engines by the same builders for the Illinois Central, illustrated last month, and for this reason we show only the photograph and sections of the firebox. It is interesting to note that the main crank pins are enlarged in the wheel fits to 7⅛ inches, while the side rod fits are 7½ inches. We hope to see this practice become general, and for all crank pins, the enlargement is also applied to the third pair of drivers in this case but not to the forward and rear wheels. The main driving journals are 9 by 11 inches. The piston rods are extended. The frames have a single bar at the front ends and these and the equalization are like those of the Illinois Central engines referred to. The Bell patent front end is used with an extension 67½ inches long from the tube sheet and 81 inches outside diameter. The air brake cylinders are placed with the rods vertical, under the boiler and immediately back of the first pair of drivers; the brake shoes are back of the driving wheels, giving an upward thrust to the frames. This is a rather important detail to which considerable attention is now given in very heavy locomotives. The bracing of the guide yoke is worthy of notice. It is supported from the rear by brackets formed by turning up the ends of the top bars of the main frames at the splice, from the boiler by a ⅝-inch plate brace and from the smokebox by 2½-inch rod braces.

The boiler is large, with 3,168 square feet of heating surface and 82.4 square feet of grate area. The grates are of the water-tube type and the firebox is 123 by 97 inches in size. The heating surface of the firebox is very large, even larger than that of the Lehigh Valley pushing engines. The latter engines have 215 square feet of heating surface in the firebox and the D. L. & W. engines have 218 feet. The firebox heating surface of the Brooks engines for the Great Northern (American Engineer, January, 1898, page 1) is the largest of which we have record, being 235 square feet. The shape of the firebox is a noteworthy example of the present tendency to maintain a uniform curve in the side sheets and to avoid the flat portions of these sheets that were formerly the rule in fireboxes of this type. The accompanying small engraving illustrates two examples from former practice in this respect on another road and the improvement will be seen at a glance. This change in the form of the firebox is believed to be a very important way to reduce the breakage of stay bolts, and this may become a strong argument in favor of this type of firebox even if the dimensions are not carried as far as in this case, where fine anthracite is used.

The height of the boiler above the rails is 9 feet 2½ inches, which is rather unusual, although it is not as great as that of the Illinois Central engines, in which this dimension is 9 feet 8 inches. The height of the center of the boiler of the large locomotive on the Union Railway above the rails is 9 feet 3⅜ inches.

The following table gives a summary of the chief dimensions of the D. L. & W. locomotives:

Type	12-wheel freight
Gauge	4 ft. 8½ in.
Kind of fuel to be used	Fine anthracite coal
Weight on drivers	166,000 lbs.
Weight on trucks	39,000 lbs.
Weight, total	205,000 lbs.
Weight, tender, loaded	106,000 lbs.
General Dimensions.	
Wheel base, total, of engine	25 ft. 9 in.
Wheel base, driving	15 ft. 0 in.
Wheel base, total, engine and tender	50 ft. 4¼ in.
Length over all, engine	37 ft. 4⅛ in.
Length over all, total, engine and tender	60 ft. 2⅝ in.
Height, center of boiler above rails	9 ft. 2½ in.
Height of stack above rails	15 ft. 1½ in.
Heating surface, firebox	218 sq. ft.
Heating surface, tubes	2,950 sq. ft.
Heating surface, total	3,168 sq. ft.
Grate area	82.4 sq. ft.
Wheels and Journals.	
Drivers, number	Eight
Drivers, diameter	54 in.
Drivers, material of centers	Cast steel
Truck wheels, diameter	30 in.
Journals, driving axle	9 in. by 11 in.
Journals, truck	5½ in. by 12 in.
Main crank pin, size	6½ in. by 6½ in.
Main coupling pin, size	7½ in. by 5 in.
Main pin, diameter wheel fit	7⅛ in.



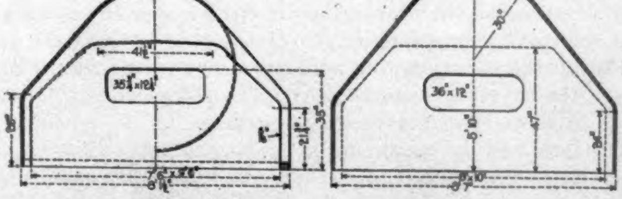
Twelve-Wheel Freight Locomotive, D., L. & W. Ry.—Sections Showing Form of the Wide Firebox.

Cylinders.

Cylinders, diameter	21 in.
Cylinders, stroke	32 in.
Piston rod diameter	4¼ in.
Main rod, length center to center	98 in.
Steam ports, length	25 in.
Steam ports, width	2½ in.
Exhaust ports, least area	110 sq. in.
Bridge, width	3¼ in.

Valves.

Valves, kind of	Improved Piston
Valves, greatest travel	6¼ in.
Valves, steam lap (inside)	1 in.
Valves, exhaust lap or clearance (outside)	Line and Line
Lead in full gear	1/16 in. negative



Sections of Older Forms of Wide Fireboxes.

Boiler.

Boiler, type of	conical connection wagon top
Boiler, working steam pressure	200 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in barrel	⅞ in. and 15/16 in.
Boiler, thickness of tube sheet	⅝ in.
Boiler, diameter of barrel, front	⅞ in.
Boiler, diameter of barrel, at throat	83⅞ in.
Seams, kind of horizontal	Sextuple lap
Seams, kind of circumferential	Triple lap
Crown sheet, stayed with	Radial stays
Dome, diameter	30 in.

Firebox.

Firebox, type	Wide, over wheels
Firebox, length	123 in.
Firebox, width	97 in.
Firebox, depth, front	74 in.
Firebox, depth, back	64½ in.
Firebox, material	Steel
Firebox, thickness of sheets, crown ⅜ in.; tube ⅝ in.; side and back ⅜ in.	
Firebox, mud ring, width	back and sides 3½ in.; front 4 in.
Firebox, water space at top	back 4½ in.; front 4 in.
Grates, kind of	Water tube
Tubes, number of	410
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in.
Tubes, length over tube sheets	13 ft. 10¼ in.

Smokebox.

Smokebox, diameter (outside)	81 in.
Smokebox, length from flue sheet	67½ in.

Other Parts.

Exhaust nozzle	Single
Exhaust nozzle, diameter	5½ in.
Exhaust nozzle, distance of tip below center of boiler	5 in.
Netting, wire or plate	Wire
Netting, size of mesh or perforation	2½ x 2½ and 2⅛ x 1¼
Stack	Steel, taper
Stack least diameter	15¼ in.
Stack, greatest diameter	17¾ in.
Stack, height above smokebox	30½ in.

Tender.

Type	8-Wheeled
Tank, type	B. L. W. sloping top
Tank, capacity for water	5,000 gal.
Tank, capacity for coal	10 tons
Tank, material	Steel
Tank, thickness of sheets	¼ in.
Type of under frame	Steel channel
Type of springs	Double Elliptic
Diameter of wheels	33 in.
Diameter and length of journals	5 in. x 9 in.
Distance between centers of journals	5 ft. 5 in.
Diameter of wheel fit on axle	6⅝ in.
Diameter of center of axle	5⅜ in.
Length of tender over bumper beams	21 ft. 8½ in.
Length of tank	19 ft. 6 in.
Width of tank	10 ft. 0 in.
Height of tank not including collar	60 in.
Type of draw gear	M. C. B. Gould

A NEW PACKING RING FOR PISTON VALVES.

The Brooks Locomotive Works.

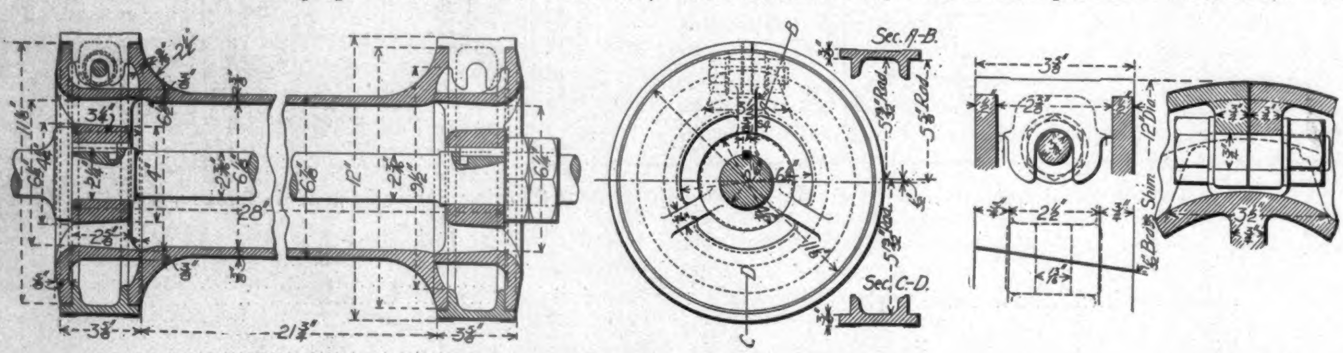
The development of piston valves for locomotives has been interesting, and by courtesy of the Brooks Locomotive Works a newly perfected improvement is shown in the accompanying engraving, which illustrates the design used in the very large 12-wheel freight locomotive for the Illinois Central, which we illustrated last month.

In our issue of June of the current volume Mr. F. M. Whyte, now Mechanical Engineer of the New York Central, directed attention to the fact that in endeavoring to secure the proper bearing area of packing rings for piston valves the tendency toward increased friction, on account of the action of the stem in setting out the packing against the bushing was not always considered. He also showed the importance of keeping the edge of the packing rings which control the admission of steam at or very near the extreme ends of the valve, in order to avoid wire-drawing of the steam in passing through the tortuous passages caused by the projecting ends of the valves past the edge of the packing. Both of these matters have received attention in the design now illustrated. The steam pressure can have no effect in changing the diameter of the packing ring and the edge of the packing is at the extreme end of the valve.

This packing is entirely different in principle from that illustrated on page 303 of our October issue. It does not depend upon close fitting to keep the steam from getting under the ring, but the ring is solid and arranged so that it does not matter whether the steam gets under it or not. The packing is made in one solid piece in the form of a bull ring, provided with lugs on the inside to permit of adjusting its size by the introduction of a shim of the proper thickness into a saw cut, through the ring, the lugs serving to provide means for bolting the joint so as to make the ring continuous as far as the steam is concerned. This packing ring is first turned up of larger diameter than the bore of the bushing. The required amount is then cut out on a bevel across the ring and a shim of the required thickness is inserted in the slot. The ring is then clamped together by a bolt, with the shim, and accurately turned up to the proper size so that the outside is a true circle. The use of the shim permits of adjustment to the proper fit in the bushing and also makes it possible to provide for wear by putting in a thicker shim.

This construction requires careful fitting of the bushing and it may be necessary to ream the bushing to accurately fit the valve after the bushing is in place. Once accurately fitted the packing ought to remain tight for a long time. This design seems to have the advantages of a plain plug valve and an additional one in that the valve may at any time be made tight after wearing, and with comparatively little expense.

The engraving shows the construction of the valve itself, the form of the follower and the method of holding the packing from turning by means of lugs cast on the follower, which embrace the joint in the packing ring. The valves of this form for the large Illinois Central engine are 12 inches in diameter. We are informed that the rings are to have several parallel grooves similar to those in the pistons of gas engines, which will probably prolong the period of tightness.



An Improved Form of Piston Valve Packing.

STORED ENERGY REQUIRED IN TRAINS AT DIFFERENT VELOCITIES.

By P. H. Dudley.

With the present heavy and long high-speed trains the stored energy required to overcome the inertia often is the limiting factor of the speed which can be attained.

The locomotive must develop this amount as well as that required to overcome all other resistances, as the wind, gradients, curves, journal and rolling friction on rails.

No. 11, one of the through trains leaving Grand Central Station with ten cars, is 809 feet long from tip of pilot to rear of buffer, the average weight being 650 tons. With eleven cars the length is 880 feet, one-sixth of a mile, quite as long and much heavier than the slow freight trains twenty years ago.

The stored energy in foot-pounds required for a 650-ton passenger train at various speeds, including 10 per cent. of rotation of wheels, is as follows:

Speed in Miles per Hour.	Foot-pounds Stored Energy Required.	Difference.
10	4,776,200	4,776,200
20	19,162,000	13,385,800
30	43,043,000	23,881,000
40	76,505,000	33,462,000
45	96,811,000	20,306,000
50	119,548,000	22,737,000
55	144,573,000	25,025,000
60	172,172,000	27,599,000

The locomotives, so far as ordinary train resistance is concerned, would have no difficulty in maintaining the speed when once attained at 50, 55 or 60 miles per hour. To raise the train from a speed of 50 to 55 miles per hour requires over 25,000,000 foot-pounds of energy stored in the train for the higher speed. With an increase of 500 pounds additional draw-bar tension, this would require a run of ten miles to store the needed energy. A signal or slow-down may reduce the speed, and all the energy from the higher to the lower speed destroyed by the brakes. The energy must be restored to the train before it can regain its running speed, but whether the lost time can be made depends upon the distance to be run and the ability of the locomotive to store up energy in the train much above the average running speed. The stored energy is also large in slower and heavier freight trains.

The recent 80-car freight trains' gross load, about 3,500 tons, at 20 miles per hour, requires over 100,000,000 foot-pounds of energy; and when the speed is increased to 30 miles per hour on a descending gradient, 277,556,000 foot-pounds. This stored energy is practically equal to that which is computed for the projectile of the new 16-inch gun when fired. The projectile will weigh 2,370 pounds, and at 2,000 feet velocity per second the stored energy will be 234,400,000 foot-pounds. A 12-inch projectile of 1,038 pounds, at 2,000 feet velocity has 52,000,000 pounds of stored energy. Our present fast passenger trains and the heavy freight trains daily develop and harmlessly destroy greater quantities of energy than the heaviest ordnance. —"New York Railroad Men."

THE SAND BLAST IN RAILROAD WORK.

The sand blast has been in use for many years and its development has been steady, but it will be more rapid now that compressed air power is so generally available. When the rotary blower was used for the air supply, the work was very satisfactory, but with higher pressures from compressors it is much more rapid and effective and the number of uses for the sand blast has vastly increased. The possibilities need only to be appreciated to compel much greater extension.

The remarkably satisfactory results with the sand blast in cleaning the old paint from the 155th St. Viaduct, New York, preparatory to painting the girders for the tests described in our August, 1898, issue, page 259, have done a great deal to show its value. The surfaces were required to be perfectly clean, which could not be accomplished by wire brushes or scrapers. At that time the engineer in charge, Mr. E. P. North, consulted 20 prominent engineers as to the advisability of using the sand blast for this purpose and the replies all stated that no better method of removing scale, rust and old paint from all parts of an iron or steel structure was known. This correspondence clearly brought out the importance of absolutely clean metallic surfaces for the reception of paint. The sand blast will reach all parts of a structure which are inaccessible to a brush and scraper, and it will do the work cheaper than any other method. This was proven some time ago by Mr. L.

Fig. 1.—King Sand Blast Machine.

F. Smith, assistant engineer in charge of bridges of the City of Baltimore, in the case of the bridge over the Pennsylvania Railroad at Argyle Ave. The bridge had not been painted for 20 years, and the rust and scale were over ¼ inch thick, the pitting was 1/16 inch deep. Hand cleaning, which was not effective or satisfactory, cost 5 cents per square foot, and on trying the sand blast the work was done both better and cheaper.

Bridge work is a large field for this process, and in fact any work requiring the removal of paint or scale from metallic surfaces, for subsequent painting, plating or enameling. It is specially successful in cleaning castings as they come from the molds. It will remove sand that is burned in, and at one operation it will prepare a rough sandy casting for nickel plating. Locomotive tenders are cleaned from old paint, car wheels are cleaned at the foundry, old files smoothed off for recutting; painted woodwork may be sanded and many other fields of usefulness have been found, such as the cleaning of the bottoms of ships.

The sand blast for the removal of paint from tenders is gaining in favor among railroads. At the Dennison shops of the P., C., C. & St. L. Ry., it has been used for this purpose for over three years, and the average cost of cleaning a tender ready for painting has been $2.50, this method being preferred to all others. This cost has probably been greatly reduced since our information was received, about 18 months ago. On the Erie quartz sand or quartz and deposit sand mixed in equal proportions are used with an air pressure of about 100 lbs. On the Atchison, Topeka & Santa Fe hand scrapers and gas burners were formerly used on tenders, chemical softening of the paint had also been tried, but these have now given place to the sand blast. A 4,000-gallon tank is completely cleaned in 4 hours and everything is cleaned off right down to the metal. If there is any pitting and progressive rusting the sand reaches it and cuts it out. On this road about 10 cubic feet of sand will clean a 4,000-gallon tank at a labor cost of 50 cents, while the entire cost does not exceed 85 cents per tender. These are figures which we have from officers of the road. Car journal brasses which have been used were formerly cleaned in a bath of lye, the sand blast is now used, and it is more rapid and also leaves the surfaces looking like new. It is used to clean driving wheels, dome casings, remove the scale from dry pipes and for many other purposes.

Mr. B. Haskell, Superintendent of Motive Power of the Chicago & West Michigan Ry., described his experience with the sand blast in a paper before the Western Railway Club (American Engineer, April, 1899, page 129), in which he said: "In

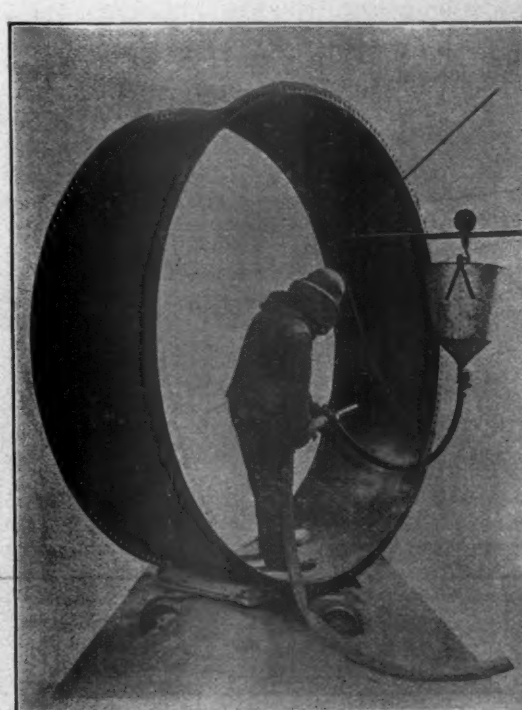


Fig. 2.—Sand Blast Machine at Work.

the preparation of a new locomotive for a priming coat of paint the surface is brought to condition by the air and sand blast, instead of by hand abrading, the latter process requiring about 35 man-hours at a cost of $3.50, while the sand blast requires two man-hours at 14 cents per hour, and two man-hours at 10 cents per hour, or 48 cents, a saving of $3.02 by the sand blast. The sand blast is also used in frosting deck glass for passenger cars, the cost for labor and material being 12 cents, a saving of 60 cents.

A very simple and satisfactory sand blast machine manufactured by the King Improved Sand Blast Co., is illustrated in the accompanying engraving. Fig. 1 shows the second of three sizes. This machine is hung from a convenient crane, and is easy to handle. A smaller one, No. 1, using air from a rotary blower at eight ounces pressure, is used for cleaning the light castings used in stoves. In this work one man with a sand blast apparatus does the work of five men with brushes. The No. 2 machine, which is shown here, is used with compressed air, and is much more powerful. It is adapted to nearly all the heavier work that may be done by the sand blast.

Three hundred car wheels can be thoroughly cleaned per day with a machine of this size.

It is desirable to have a room about 10x10x10 feet set apart for the cleaning. A small exhaust fan may be arranged to keep the air free from dust. A sharp or quartz sand is required; it should be perfectly dry and free from all foreign substances which would tend to clog the sand valve or hose. The sand may be used over and over until too fine to cut effectually. The bucket may be hung by a small block and fall, the rope passing down and around the trolley, thus enabling it to be raised and lowered at will, or it may be hung on a swinging arm. The flow of sand is governed by the valve placed immediately below the bucket.

A tank of about 60 gallons capacity, provided with a pressure gauge, should be located in the cleaning room. The main air pipe is tapped and a 1-inch pipe led from it to the tank. Immediately before entering the tank a globe valve is placed, within easy reach of the operator, and by this valve the amount of air entering the tank is governed, only enough being allowed to enter to maintain the volume and pressure required for the sand blast machine. The outlet from the tank should be 2-inch, the air hose on the machine being connected thereto. At a convenient point in the room a ⅜-inch hole is tapped in the air pipe and the hose on the operator's helmet connected. A chilled mouthpiece is provided to take the wear of the sand at the nozzle.

The address of the King Improved Sand Blast Co. is Station C., Detroit, Michigan.

"DOUBLE END" CONSOLIDATION LOCOMOTIVE.

Dominion Coal Co., Cape Breton.

Built by the Schenectady Locomotive Works.

There is nothing new in the idea of double end locomotives for such service as that of the Sidney & Louisberg Railway for the Dominion Coal Co., but the one which we illustrate is believed to be among the largest of this type ever constructed. These engines were designed to conform to the particular conditions of this service and they are powerful and heavy. Photographs of mogul and consolidation types have been received, but we show only the consolidation, as it is much heavier and larger than the other.

The cylinders are 22x28 inches, the boiler is 72 inches in diameter, with 2689 square feet of heating surface and 33 square feet of grate area. The total weight is 239,000 lbs., and the weight on drivers is 170,000 lbs. The engine is large and powerful, but large coal and water-carrying capacity is not needed, as the runs are probably comparatively short. The engines have gone into service and the reports of their performances are very satisfactory. They are equipped with American brakes, Leach sanders and Star chime whistles. The leading dimensions are given in the following table:

"Double End" Consolidation Locomotive.

Dominion Coal Company, Cape Breton.

Built by THE SCHENECTADY LOCOMOTIVE WORKS.

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order	239,000 lbs.
Weight on drivers	170,000 lbs.
Wheel base, driving	15 ft. — in.
Wheel base, rigid	15 ft. — in.
Wheel base, total	36 ft. 3 in.

Cylinders.

Diameter of cylinders	22 in.
Stroke of piston	28 in.
Horizontal thickness of piston	5½ in.
Diameter of piston rod	3¾ in.
Kind of piston packing	Cast iron
Size of steam ports	18 in. by 1¼ in.
Size of exhaust ports	18 in. by 2¾ in.
Size of bridges	1⅛ in.

Valves.

Greatest travel of slide valves	5½ in.
Outside lap of slide valves	¾ in.
Inside lap of slide valves	1/32 in.
Lead of valves in full gear	1/16 in.

Wheels, Etc.

Diameter of driving wheels outside of tire	55 in.
Material of driving wheel centers	Main, cast steel; intermediate, forward and back, steeled cast iron
Driving box material	Main, cast steel; intermediate, forward and back, steeled cast iron
Diameter and length of driving journals	Main only 9 in. dia. 8½ in. dia. by 10 in.
Diameter and length of main crank pin journals	(Main side 7¼ in. by 5 in.) 7 in. dia. by 6½ in.
Diameter and length of side rod crank pin journals	(F. & B. 5 in. by 3½ in.) inter. 6 in. dia. by 4½ in.
Engine truck, kind	Two-wheel swing bolster
Engine truck journals	6 in. dia. by 10 in.
Diameter of engine truck wheels	30 in.

Boiler.

Style	Straight
Outside diameter of first ring	72 in.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	23/32 in. 9/16 in. ½ in. and 11/16 in.
Firebox, length	114 in.
Firebox, width	41⅞ in.
Firebox, depth	F. 70½ in. B. 67½ in.
Firebox plates, thickness,	Sides 5/16, in. back 5/16, in. crown ⅜ in, tube sheet ½ in.
Firebox water space	Front 4 in., sides 3½ in., back 3½ in. and 4 in.
Firebox, crown staying	Radial stays, 1⅛ in. dia.
Firebox stay bolts	1 in. dia.
Tubes, number of	348
Tubes, diameter	2 in.
Tubes, length over tube sheets	13 ft. 10 in.
Fire brick, supported on	Studs
Heating surface, tubes	2,512.55 sq ft.
Heating surface, firebox	176.92 sq. ft.
Heating surface, total	2,689.47 sq. ft.
Grate surface	33.21 sq. ft.
Grate, style	Rocking
Ash pan, style	Sectional, damper front and back
Exhaust pipes	Single, high
Exhaust nozzles	5¼ in., 5½ in., 5¾ in. dia.
Smoke stack, inside diameter	16 in.
Smoke stack, top above rail	14 ft. 9 9/16 in.

Tender.

Wheels, number of	4
Wheels, diameter	28 in.
Journals, diameter and length	5 in. dia. by 9 in.
Trucks	Four-wheel, center-bearing, swing-spring bolster carrying back end of engine
Water capacity	4,200 U. S. gallons
Coal capacity	4 tons

PERSONALS.

Mr. Lucius Tuttle, President of the Boston & Maine, has been elected President of the Maine Central also, to succeed Mr. F. A. Wilson.

William H. Smith, for several years Purchasing Agent of the Schenectady Locomotive Works, died at his home in Schenectady, N. Y., Oct. 14.

Mr. Rollin H. Wilbur, General Superintendent of the Lehigh Valley, has removed his headquarters from South Bethlehem, Pa., to 26 Cortlandt street, New York.

Mr. W. C. Alderson, Purchasing Agent of the Lehigh Valley, has been promoted to the position of Treasurer of the company, to succeed Mr. J. A. Harris, resigned.

Mr. James A. Gaston has resigned as Master Car Builder of the Louisville, Evansville & St. Louis, to take the management of the Bryant Paint Co. at Cincinnati.

Mr. George F. Evans has severed his connection with the Westinghouse interests, having resigned as manager of the Westinghouse Manufacturing Company, Ltd., Canada.

Elbridge G. Allen, who was General Superintendent of the Old Colony Railroad from 1893 to May 1, 1898, shot and killed himself at the Grand Union Hotel, New York City, recently.

Mr. S. F. Forbes, Purchasing Agent of the Great Northern, has resigned, to accept the position of Assistant Superintendent of Motive Power of the Central Railroad of New Jersey, with office in Jersey City.

Mr. Charles P. Coleman has been appointed Purchasing Agent of the Lehigh Valley Railroad, with headquarters at Philadelphia, Pa. He was formerly purchasing agent of the Bethlehem Iron Company.

Mr. A. C. Henry, Purchasing Agent of the Canadian Pacific at Montreal, has been appointed General Purchasing Agent of the entire system, and Mr. E. N. Bender has been appointed Assistant Purchasing Agent.

Mr. George W. Smith, Superintendent of Machinery of the Santa Fe Pacific, has had his jurisdiction extended to include the San Francisco & San Joaquin Valley. His office will remain at Albuquerque, New Mexico.

Mr. G. F. Jones, who has for 14 years held the position of Secretary of the Richmond Locomotive Machine Works, has resigned and accepted the position of Southern Representative of the Baldwin Locomotive Works, with headquarters in Richmond, Va.

Mr. Alfred Lovell, who has been connected with the motive power department of the Northern Pacific for a number of years, and was recently made Assistant Superintendent of Motive Power, has just been appointed to succeed Mr. William Forsyth as Superintendent of Motive Power.

Mr. J. W. Taylor was appointed secretary of the Western Railway Club at the September meeting, to succeed Mr. F. M. Whyte, who resigned upon his removal from Chicago to become mechanical engineer of the New York Central. Mr. Taylor is now also secretary of the Master Car Builders' and Master Mechanics' Associations.

Mr. Harvey Middleton, Mechanical Superintendent of the Baltimore and Ohio Railroad, has tendered his resignation. Mr. Middleton began railroading in 1876, with the Philadelphia & Erie, and has since held the positions of Master Mechanic on the Louisville & Nashville, Superintendent of Machinery on the Atchison, Topeka & Santa Fe, Superintendent of Motive Power of the Union Pacific, and Superintendent of Construction of Pullman's Palace Car Co. He was appointed several years ago to succeed Mr. Geo. B. Hazlehurst, on the Baltimore & Ohio, and has done very important work in introducing heavy motive power and improving the arrangements of the shops of the road.

Mr. Robert C. Blackall, according to an official circular just received, has retired from active service as Superintendent of Motive Power of the Delaware & Hudson Co., and is appointed Consulting Mechanical Superintendent. The duties of Superintendent of Motive Power will be performed by Mr. J. R. Slack, Assistant Superintendent of Motive Power, with headquarters at Albany, N. Y.

Mr. W. I. Allen, who has for nine years held the position of Assistant General Manager of the Chicago, Rock Island & Pacific, has resigned in order to devote his entire attention to his private interests. The jurisdiction of Mr. A. J. Hitt, General Superintendent of the lines east of the Missouri River, has been extended over the entire system and the position of Assistant General Manager has been abolished.

Mr. Roswell Miller, the retiring President of the Chicago, Milwaukee & St. Paul, was at a recent meeting of the stockholders made Chairman of the Board. Mr. Miller began his railroad career with the Cairo & Vincennes, of which he was Secretary and General Superintendent. In 1882 he was Second Vice-President and Treasurer of the Chicago & Western Indiana. From there Mr. Miller went to the C., M. & St. P. as Assistant to the General Manager, and later was made General Manager and finally President.

Mr. Charles P. Clark, President of the New York, New Haven & Hartford, has tendered his resignation on account of continued ill health. When the matter came before the Board of Directors no definite action was taken and it is uncertain when the resignation will go into effect. Mr. Clark has had a long and very successful career. Much of the burden of the consolidations which have produced the present large system operated as the New York, New Haven & Hartford Railroad, was carried by him, and he also conducted a number of large enterprises, such as the track elevation in Boston and the consummation of the improvements at the Boston terminal. He has earned a rest from his arduous labors.

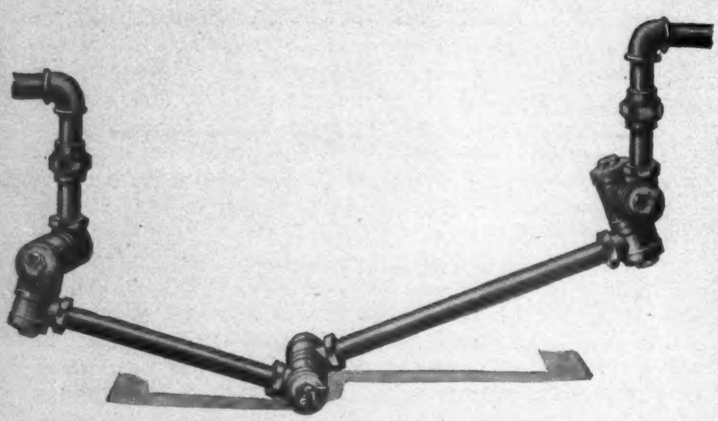
Mr. J. N. Barr has resigned as Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul to become Mechanical Superintendent of the Baltimore & Ohio, to succeed Mr. Harvey Middleton, who has resigned. Mr. Barr is a graduate of Lehigh University. He entered railroad service with the Pennsylvania at Altoona and after working up to an important position in the shops there he was appointed Mechanical Engineer of the Chicago, Milwaukee & St. Paul in 1885. In 1886 he was appointed Superintendent of the Car Department of that road and in 1888 he became Superintendent of Motive Power, which position he has held until the present. Mr. Barr is one of the strong men in motive power matters, to which the excellent condition of the motive power of the St. Paul road testifies. His most important work, aside from the generally good administration of the department, has been in the development and improvement of the chilled cast-iron wheel. As the inventor of the Barr contracting chill he has exerted a wide influence in the safety of railroad operation, which began before he left Altoona. He has invented a number of minor parts in car and locomotive construction and is recognized as a leader in the application of engineering, combined with common sense, to the management of the motive power department. He takes a wide, successful and well-seasoned experience to his new position and is a valuable acquisition to the staff of the Baltimore & Ohio.

THE CLIMAX FLEXIBLE METALLIC JOINT.

The accompanying engravings illustrate a simple, strong and inexpensive metallic joint for use in steam-heat equipment for trains, and also in stations and yards for making steam connections with cars for the purpose of heating them up before the attachment of the locomotive. The engravings show the exterior appearance of a joint for connecting a locomotive and tender, and it will be seen that no bolts are used.

A Climax Double Joint.

It is stated that the joint becomes tighter with the increase of pressure, and that it will work without leakage when comparatively loose. In a locomotive conduit two double and one single joint are used. They are made entirely of steam metal and appear to be strong and durable. There does not appear to be any possibility for oil, hot ashes or dirt to affect the life of these joints. The two portions of the swinging joint are held together by a sleeve coupling with flanges bearing against packing washers of durable material. One of these flanges is a part of the sleeve and the other is threaded and



Application of Joint Between Engine and Tender.

secured after the proper adjustment is made. A similar joint has been in use for several years in service severe enough to give confidence in its wearing qualities. One of the strong features is the relatively low cost at which this joint is sold. It is offered for sale by Mr. F. G. Street, 535 Temple Court Building, Chicago, Ill.

THE GABRIEL STAY-BOLT CHUCK.

In the report of the committee on "Best Method of Applying Stay-Bolts to Locomotive Boilers," presented to the Master Mechanics' Association at the recent convention, considerable attention was given to the manner of screwing the bolts into the sheets. The report illustrates several methods, those in which the ends of the bolts are squared to receive a wrench and others in which the end of the bolt is entered into a clutch which grips the bolt tightly enough to turn it into place without specially preparing the end for the purpose. In the discussion, a device of this kind used on the Pennsylvania Railroad was described.

Gabriel Stay-bolt Chuck.

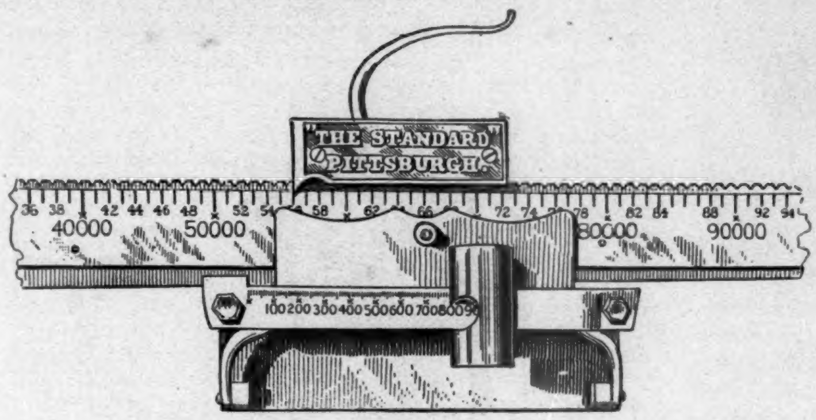
The accompanying engraving illustrates a newly patented device of this kind, known as the "Gabriel Stay-Bolt Chuck," which is manufactured and sold by the Chicago Pneumatic Tool Company, 634 Monadnock Building, Chicago. This chuck is shown in use in connection with the Boyer piston air drill. The chuck is arranged to grasp stay-bolts of any of the usual sizes, and it will turn them into the sheets without squaring up the ends. When driven by the air motor this work is done very rapidly, with a great saving of labor over the usual method of turning them in by hand.

Progress in the use of paint spraying machines was one of the subjects discussed by the Master Car and Locomotive Painters' Association at its recent convention. The prevailing opinion was that little progress had been made during the year. One member stated that difficulty had been experienced because at times the air is damp and the pressure from yard piping was not uniform on account of the variation in the demands for air. Another member stated that from a test on 573 cars, comparing the spray with brush work, he had found that the brush increased the cost of labor by $186.22 over that of spraying, whereas the increase in the cost of paint due to the sprayer was $489.91.

REED RECORDING ATTACHMENT

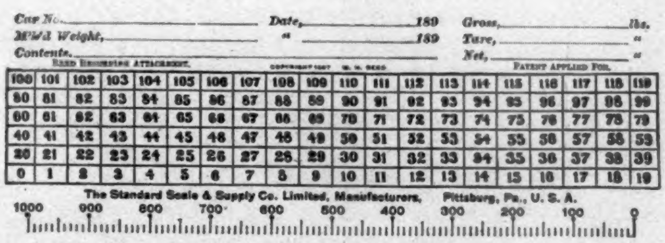
For Railroad Track Scales.

This is a simple appliance for the purpose of obtaining a permanent and positive record of the reading of a scale of the railroad track type. With it the weight may be taken with or without reading the beam. The accompanying engraving illustrates a track scale bearing this attachment. The main



Reed Recording Attachment for Railroad Track Scales.

beam is graduated by 1,000-pound marks and the small beam by 10-pound marks up to 1,000 pounds, the sliding poises being as free to move as without the attachment. The beam is notched in the usual way and in the beam puncturing pins are placed at intervals on an incline to correspond with lines of figures printed on a card which has headings to record the car number, marked weight, contents and the date of weighing. The large poise carries a card holder and the small poise has a brass casting and a puncturing pin which extends back of the card holder. After the beam is balanced the holder is pressed toward the beam and the recording pins puncture the card and supply the permanent record of the locations of the poises. One movement records the total weight of the load, and the card holder is the only additional movable part which this device adds to a scale. The correct weight may be had in less time than is required to read the beam. The device is in use by about 25


Car No. ________ Date, ________ 189 Gross, ________ lbs.
M'k'd Weight, ________ " ________ 189 Tare, ________ "
Contents. ________ Net, ________ "
REED RECORDING ATTACHMENT. PATENT APPLIED FOR.

100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

The Standard Scale & Supply Co. Limited, Manufacturers, Pittsburg, Pa., U. S. A.

1000 900 800 700 600 500 400 300 200 100 0

Record Card Reduced to About Half Size.

prominent furnaces and steel concerns and also by a number of railroads, a list of which will be printed in a future reference to this device in our next issue. We have seen letters from officers of several of these roads expressing satisfaction with the device. It is manufactured and sold by the Standard Scale & Supply Company, Ltd., 211 Wood Street, Pittsburgh, Pa.

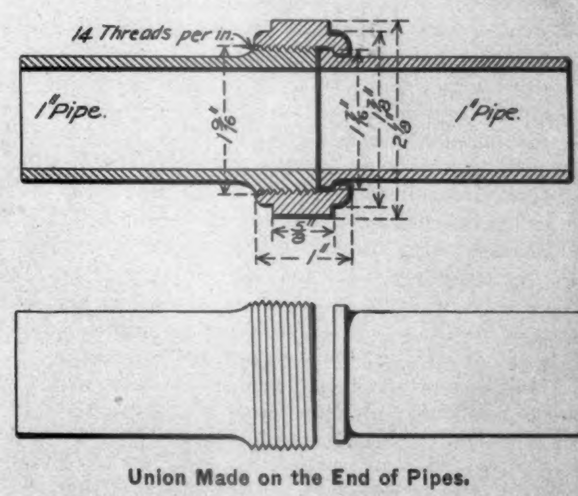
Two more compound locomotives of the tandem type, on the plan patented by Mr. John Player, Superintendent of Motive Power of the Atchison, Topeka & Santa Fe, are to be built at the Topeka shops of that road. These are to be in accordance with the system illustrated and described in our issue of June, 1899, page 211. They are to have 77-inch driving wheels and will be used in passenger service. The reports of the performance of this type of locomotive on this road appear to continue to be favorable.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

On Wednesday, September 27, the exercises of the Massachusetts Institute of Technology began. Since the end of the last term some changes have been made in the faculty. Adolph Rambeau, Ph. D., has been made Professor of Modern Languages, and has charge of that department. Arthur A. Noyes, Ph. D., formerly Associate Professor of Organic Chemistry, has been made Professor of Theoretical and Organic Chemistry. Jerome Sondericker, C. E., formerly Assistant Professor of Applied Mechanics, has been made Associate Professor of Applied Mechanics; Allyne L. Merrill, S. B., formerly Assistant Professor of Mechanism, has been made Associate Professor of Mechanism; Edward F. Miller, S. B., who was Assistant Professor of Steam Engineering, has been made Associate Professor of Steam Engineering; Carleton A. Read, S. B., who was an Instructor in Mechanical Engineering, has left to take charge of the Mechanical Engineering Department in the New Hampshire College at Durham; George V. Wendell, Ph. D., has returned from three years' study in Germany and resumes his duties as Instructor in Physics; Frederic H. Keyes, S. B., and Alexander W. Moseley, S. B., have left to take up professional work; Frederick A. Hannah, S. B., has accepted a position in the Mechanical Department of the Brooklyn Polytechnic Institute.

PIPE UNIONS MADE DIRECTLY ON THE END OF THE PIPE.

The accompanying engraving illustrates a new pipe union devised by Mr. T. R. Browne, Master Mechanic of the Juniata shops of the Pennsylvania Railroad at Altoona. The first glance at the sketch shows the clear opening through the joint, which is entirely free from obstruction. This is not true of the ordinary commercial unions. These new unions are made by a very simple process on a bolt header by use of a pair of dies. In each case the external die is formed to the shape of the finished piece. The internal die consists merely of a plunger



Union Made on the End of Pipes.

of two diameters, the larger representing the larger diameter of the union and the smaller diameter corresponding with the inside diameter of the pipe. The dies are so made that before any upsetting takes place on the pipe the internal die has entered the external die in such a way as to form a closed or solid die. This method permits of the use of the next smaller size of standard union nut than would be used with the standard union. For example, for a 1-inch union made in this way a standard nut for a ¾-inch union may be used. These unions are very simple and neat and they possess the advantage of reducing the number of joints and opportunities for leakage, as well as making a very strong joint.

THE "MONARCH" PNEUMATIC HAMMER.

The accompanying engraving shows the appearance of the "Monarch" pneumatic hammer recently placed on the market by the Standard Railway Equipment Company, 210 Vine Street, St. Louis. The company is interested in other pneumatic tools, but particular attention is now being given to two sizes of pneumatic hammers. These are designated as style "A" and

The Mona ch Pneumatic Hammer.

style "B." The former is for light work, such as caulking, flue beading and light chipping, while the latter is for heavier work about the construction of boilers, where a heavier hammer is required. The ferrules of these hammers are either round or hexagonal. It is claimed by the manufacturers that these hammers are very economical in the use of air and that while they strike hard blows the plungers are cushioned in such a way as to reduce the vibration to a minimum. The ports in the cylinder are so arranged as to prevent the hammer from operating when the chisel is removed from the shank. The valve is very simple and is made of hardened steel. A strong claim is made for their satisfactory operation without derangement. The Standard Railway Supply Company states that these hammers will be furnished on 10 days trial to those desiring to test their qualities.

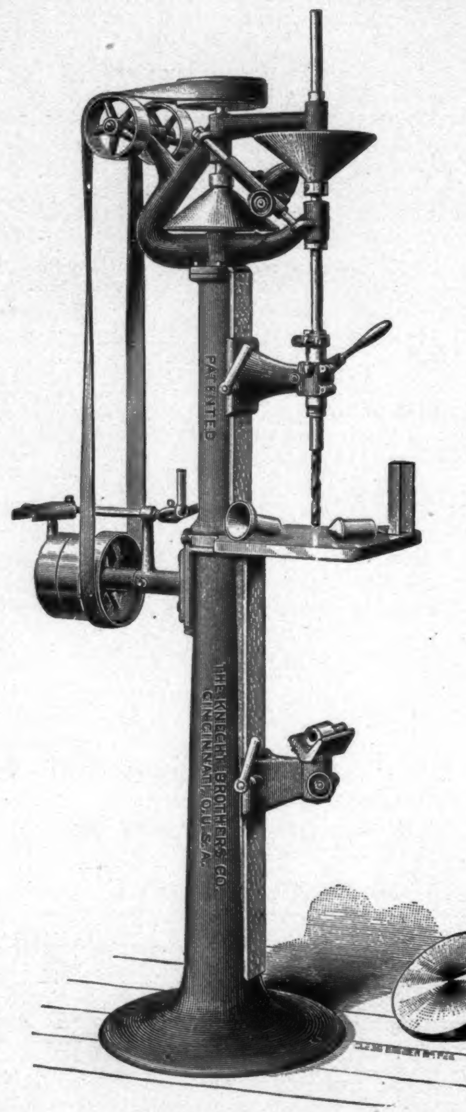
FRICTION SENSITIVE DRILL.

Knecht Brothers Company, Cincinnati, O.

It is evident that an unusual amount of thought and experience has been applied to the development of this machine. Our attention was called to it by a letter from Mr. David Hawksworth, the well-known Superintendent of Motive Power of the Burlington & Missouri River Railroad, in which he said: "The drill is giving entire satisfaction and you may refer any prospective purchaser to me."

The driving mechanism consists of two cones with a friction roller bearing between them, the roller being adjustable in position for the purpose of changing the speed of the spindle. This may be done while the machine is running and without changing or shifting belts. The range of adjustment is 4½ inches, which is sufficient to provide for drills from the smallest up to a diameter of 9/16 inch. The power varies as the speed is changed and it, and also the speed, is adjusted for each size of drill by means of a graduated bar upon which the journals of the friction roller are supported. This bar is marked for the different sizes of drills. A screw clamps the roller in the desired position and the speed may be adjusted accurately by the marks on this bar. The necessity for varying the power of a machine of this kind is obvious. The presence of hard spots in the work causes trouble with drill presses which are not sufficiently sensitive. In this machine the pressure of the friction roller between the two cones may be adjusted very finely by turning the hand adjusting nut under the lower driving cone enough to give the power required to turn the drill that is to be used. In case the drill should bind or be strained by imperfections in the material the driving mechanism will slip and afford relief by stopping the drill. This adjustment is within easy reach of the operator. The depth to be drilled is indicated by graduations on the sleeve passing through the spindle head and a stop collar is placed on the spindle sleeve which may be set for any desired depth of hole, or it may be removed entirely by turning out the binding screw. This collar may be set so as to drill any desired number of holes to a fixed and uniform depth without reference to the graduation on the sleeve. The attachments and adjustments are all within easy reach of the operator from the front of the machine.

The spindle is relieved from lateral pressure by the mounting. The cone driving the spindle is mounted on a sleeve or bushing which extends through both bearings in the frame, and the spindle may be run continuously without danger of heat-



The Knecht Sensitive Drill.

ing. This spindle sleeve has ball thrust bearings. The machine is driven by a belt, the slack or stretch of which may be taken up by moving the countershaft bearing down on the column and securing it by means of a small adjusting screw in the slot in the column. The drill press has a square and a round table swinging on the column so as to be easily turned out of the way when the drill is to be applied to work held in the knee below. This knee is fitted with a number of attachments for receiving work of various shapes. It has a cup center for drilling the ends of shafts and mandrels, a center point, and a V-shaped block with a stem for drilling shafts at right angles with their axes.

The distance from the column to the center of the spindle is 6½ inches; the maximum distance from the end of the spindle to the table is 28 inches; the vertical adjustment of the spindle head 13 inches; the throw of the spindle is 3 15/16 inches. The floor space required is 20 by 34 inches, and the speed of the countershaft is 460 revolutions per minute. The manufacturers, the Knecht Brothers Company, Cincinnati, Ohio, may be addressed for further information.

BOOKS AND PAMPHLETS.

Poor's Manual of the Railroads of the United States, 32d Annual Volume, with an Appendix containing a full Analysis of the Debts of the United States, the several States, Municipalities, etc.; also Statements of Street Railroad and Traction Companies, Industrial Corporations, etc. New York: H. V. & H. W. Poor, 44 Broad St. 1899. Price, $7.50.

We have just received the 32d annual number of Poor's Manual, in which is given, in great detail, statistics of the financial condition and results of operation of all railroads in the United States. Our readers do not need to be told what this indispensable work contains. It is sufficient to say that it is brought up to date in the present volume with the addition of important information which was not given in former editions. The object of this publication for a number of years was to give the public a faithful abstract of the reports of the railroads and to supply the lack of such government summaries of the operation of American railroads as are given in the Board of Trade Reports on British Railroads. This information is now collected by the Interstate Commerce Commission, but the reports are not published until at least a year later than Poor's Manual. Every one who has occasion to use railroad statistics fully understands the value of promptness in their publication. The volume before us includes a new feature, a chapter in the introduction entitled "A Study in Railway Statistics," which is a review of the statistics of the development, finances, etc., of the railroads of this country, with special reference to the period from 1880 to 1889. In this chapter will be found an account of the beginnings of the railroads and a statement showing, by states and groups of states, the terminal points and mileage of all railroads which were completed and in operation in the United States in 1840. We believe this information to be very valuable and it has not before been available. Its compilation must have been exceedingly difficult. In this chapter a table gives the mileage in operation in 1851, with the passenger, freight and total earnings. Another gives the annual progress in railroad construction in the whole country between the years 1849 and 1860. Another table, of historic value, gives the termini of the first section of each road opened, the length of the section and date of opening. These new features will undoubtedly be appreciated. There appear to be no other new departures, although the entire work must necessarily improve in completeness each year as a result of the careful methods of the publishers.

U. Baird Machinery Company.—A comprehensive and well arranged catalogue has been received from the U. Baird Machinery Company, Pittsburgh, Pa. It has 232 pages, standard size (9 by 12 inches), and is well printed, the descriptions being supplemented by uniformly good engravings. The paper, type and printing are also excellent. The descriptions are in four languages, English, German, French and Spanish, and dimensions are given in English and metric systems. Code words (Lieber Code) are given in connection with all of the specialties described. A large amount of space, 33 pages, is devoted to engine lathes; this subject is followed by planers, turret lathes, punches and shears, boring and turning mills, upright drills, universal hand milling machine, cranes (25 pages), air hoists and trolleys, portable motor, belt and steam-driven air compressors for light and heavy work, high altitude air compressors, mine compressors, compound steam compressors, pneumatic riveters, sprue cutters, magnetic chucks (for planers, shapers and grinders), rotary chucks, dynamos, twist drills, reamers, lathe dogs, tool grinders and pneumatic drilling and tapping machines. The catalogue closes with a series of tables comparing the metric and English units, which is followed by an index in the four languages used in all the descriptive matter. The catalogue is a convenient one for purchasers in this country and it is specially adapted to the requirements of foreigners. It is evident that this company appreciates a very important item in securing foreign trade, that of presenting information in the language and system of measurement used in other countries. The catalogue is from the Chasmer-Winchell Press.

The Joseph Dixon Crucible Co. have distributed a new pamphlet of 20 pages (not standard size) concerning the use of Dixon's Ticonderoga Flake Graphite for cylinders and valves. Some of the information it contains has been issued in previous pamphlets; the one before us, however, combines the information concerning the lubrication of valves and cylinders with graphite. Graphite is strongly recommended in cases of high temperature and superheating, where oil is more or less troublesome on account of the effects of the high temperatures. Graphite is recommended for use in giving "body" to mineral oils, and it is not affected by the highest temperatures used. Its satisfactory action appears to be due to the filling up of minute inequalities in the bearing surfaces, making an ideally smooth surface. The pamphlet contains information concerning graphite and includes a large number of letters received from engineers who have used it successfully.

The Boston Belting Company have issued a handsome little pamphlet of 24 pages from the Barta Press, Boston, entitled "Suggestions." It contains interesting information about the history and origin of rubber manufacture with these works in 1828, the development of the large field filled by manufactured rubber goods and the impression given is that anyone desiring India rubber goods of any description will do well to consult these manufacturers. An excellent idea of the method of collecting the raw material is presented by a series of attractive illustrations with explanatory captions. A printed list of 75 items gives a good idea of the large number of different rubber specialties made by this concern. Copies of this attractive pamphlet may be had by addressing the Boston Belting Company, 256 Devonshire St., Boston, Mass.

EQUIPMENT AND MANUFACTURING NOTES.

The Q and C Co. announce that they have arranged for the exclusive control of the sale of "Magnolia Anti-Friction Metal" to the steam and electric railroads of the United States, Canada and Mexico.

The McConway & Torley Co. have an exhibit in the railroad annex at the Philadelphia Export Exposition consisting of the Janney standard coupler and a Buhoup three-stem freight coupler.

The Joseph Dixon Crucible Co. have an exhibit of their graphite productions at the National Export Exposition, Philadelphia. It is located in the southern end of the main exhibition hall, Section M-7. Our readers are invited to visit it.

The National Electric Car Lighting Co. of 100 Broadway, New York, who have developed the "Axle Light" system for railroad cars, have sold and transferred their entire assets and patent rights to the Electric Axle-Light and Power Co. The new company will continue the business and develop it. All communications should be addressed to the Electric Axle-Light and Power Co., 100 Broadway, New York. Mr. Max E. Schmidt continues in the management of the enterprise.

The Schoen Pressed Steel Car Co. is exhibiting three steel cars at the Export Exposition in Philadelphia. The first is a double hopper gondola of the Pennsylvania Railroad of 100,000 lbs. capacity, weighing 39,400 lbs. There is also an 80,000 lbs. flat floor gondola from the Union Pacific, weighing 31,500 lbs., and a 100,000 lbs. flat car of the North Shore Terminal R. R. weighing 25,800 lbs. This car has a steel deck. The cars are well located and will attract the attention of foreigners attending the Exposition. They constitute one of the most representative exhibits of new American industry.

The Chicago Pneumatic Tool Company has secured the services of Mr. C. E. Walker, who has been for the past five years Master Mechanic of the Baltimore & Ohio Southwestern Railway, at Washington, Indiana, as their representative in Cincinnati. Mr. Walker served as apprentice in the machinist's trade at the National Locomotive Works, Connellsville, Pa. In 1879 he entered the service of the C. B. & Q. R. R., and has been promoted steadily. He will attend to the interests of the Chicago Pneumatic Tool Company in Cincinnati and the contiguous territory. His familiarity with railroad shop practice renders him a valuable addition to the staff he now enters.

The Magnolia Metal Co. announce that the Q & C Co., of Chicago and New York, have become the exclusive agents for the sale of Magnolia metal to the railroads of the United States, Canada and Mexico, and that the Metal Sales Co., 15 South Water street, Cleveland, Ohio, have been appointed sole agents for Ohio, Indiana and Michigan.

The Union Boiler Tube Cleaner Company of 253 Penn Avenue, Pittsburgh, Pa., has recently finished the largest contract ever awarded for cleaning boilers, being for twenty-two watertube boilers, containing an aggregate of ten miles of four-inch tubes, a task which we believe no other concern in the world has the equipment to accomplish. They have just shipped their eighth machine to Great Britain. The initial machine for export had been shipped just one year previously. One of the latter was a repetition of the first order.

The Chicago Pneumatic Tool Company writes that the ten new Boyer pneumatic riveting hammers with long stroke, which have been in use for some time at the works of the Pressed Steel Car Company at Allegheny, have proven so satisfactory as to lead to an order for 60 more. These hammers are used for riveting in the construction of steel cars, and they have shown themselves to be durable and rapid, effecting a marked saving of labor and contributing to increasing the productive capacity of the works. They were selected as a result of severe service tests and this substantial order indicates the success which they have made. We are informed that orders for these hammers are already taxing the facilities of the manufacturers to turn them out.

We are informed that a bale of Zelnicker's "Dynamo" waste will be sent on trial to those who desire to try it practically. We have before directed attention to the fact that Mr. Zelnicker is a manufacturer and agent for mill and shop supplies, including engines, boilers and machinery. He is prepared to furnish everything used in the construction, operation and maintenance of railroad shops, and among his specialties is the "Zelnicker Prepared Roofing," which is strongly recommended for roundhouses and warehouses. He makes a specialty of second growth hickory maul and hammer handles. He is agent for the "Positive" nut lock washers, the Cyrus Roberts hand and push cars, the Johnston wrench, and for the product of the Trenton Iron Works. His address is 202 North Third St., St. Louis, Mo.

Two new blast furnaces having a capacity of 1,400 tons of iron per day will be added to the plant of the Carnegie Steel Company, Limited, on the site of the Carnegie-Carrie furnace property, directly across the river from the Homestead plant, and a double-track steel railroad bridge will be built across the river at this point. The melted iron will be run across the river in ladle cars, for use in open-hearth steel making, or in Bessemer converters. The Duquesne plant is also to be enlarged by the addition of an open-hearth steel plant and a reversible blooming mill. The estimated cost of the improvements is between $7,500,000 and $8,000,000. This is a satisfactory indication of the opinion of the Carnegie people that the present activity in the iron and steel business is to continue.

The Ajax Metal Co. of Philadelphia are adding to their testing department one of the very latest improved testing machines, and in future they will not only be able to make analytical and microscopic tests, but also physical tests, such as to bring out friction, wearing and compressive qualities. In other words, they propose to make practical tests of all material entering into the journal boxes used in railroad service, which will consist of bearing metals, oil and waste. These demonstrations will be published in the trade papers as they progress, using standards of all material in comparison, taking those that are largely used in the service, and those that are not but should be used. Mr. J. G. Hendrickson, president of the company, is thoroughly familiar with the lubricating qualities of oils, having been connected with the Standard Oil Co. prior to taking up the metal business. The Ajax Metal Co. will be pleased to correspond with all who are interested.

The exhibit of the Standard Wheel Works at the Export Exposition now open in Philadelphia includes an interesting variety of wheels and steel tires of their manufacture. A 78-inch locomotive tire attracts attention, and while not the largest in use in this country it is an example of good workmanship and material in a very large wheel. The wheels shown include a 24-inch wrought spoke center, a 34½-inch wrought spoke center with bolted tire connection, a 36½-inch cast iron plate center wheel with steel tire, a 30-inch cast iron center wheel for the "Big Four," a 72-inch cast steel driving wheel center, a 42-inch spoke center steel tired wheel for the Moscow, Kieff & Veronesm Ry., and a 42-inch cast center wheel for the Chicago & Northwestern Ry. The steel castings are admirable examples of sound and smooth work which should add to the confidence in cast steel as it is now made by the best manufacturers.

Cling-Surface is a name becoming very well known in the manufacturing world, if inquiries and business success are an indication. The Cling-Surface Mfg. Co., of 123-129 Virginia St., Buffalo, N. Y., report that they have just established a branch in Johannesburg, South Africa, to meet the increased demand for Cling-Surface in that section from those who have been compelled to run their belts as tight as possible to prevent slipping. A recent letter from a prominent mechanical engineer says: "Being somewhat skeptical as to the virtue of any belt dressing, it was some time before I concluded to try Cling-Surface, and only after being driven to it, as our belts were badly overloaded and showed signs of rapid depreciation. Your Cling-Surface was a complete revelation to me, and belts that formerly had to be run so tight as to cause a great deal of noise are now running slack and quiet, with not the least evidence of slipping. I heartily recommend it for leather belting, for in addition to its increasing the pulling capacity of a belt, I find the belts are soft and show a fine, glossy, yet very clinging surface."

The Bullock Electric Manufacturing Company of Cincinnati reports sales for the month of September involving sixty-one machines ranging in size from three to one hundred and fifty kilowatts. Among the more important were fifteen engine-type generators for United States Army transports and ten 50-horse-power motors to operate at 200 R. P. M., for Messrs. Dick, Kerr & Co. of London, England. Several repeat orders were received, among them being the following: Maryland Steel Company, Baltimore, Md., third order; Consumers' Park Brewery, Brooklyn, N. Y., third order; Atlas Cement Company, Northampton, Pa., fifth order; Missouri Lead and Zinc Company, Joplin, Mo., third order. When representative concerns such as those named find it to their advantage to continually add to their equipment of Bullock apparatus it indicates that the machines have given perfect satisfaction. A new Bulletin, No. 2,345, just issued by the company, describes Type "N" motors. This is the first bulletin of the standard 6 by 9-inch size which has been issued. We believe those interested in electrical literature will appreciate this reduction in size, as it is more readily filed than the larger pamphlets. It may be had by addressing the company.

The J. G. Brill Co. have an exhibit of cars and trucks at the Export Exposition in Philadelphia. It is in the railroad annex and consists of one of the new convertible street cars, four trucks, including the "Perfect" truck, and a street sprinkling car. The convertible car is interesting and it appears to be a solution of the problem of combining the open summer car and the closed car for winter use in the same structure. The car has lateral seats and a center aisle. The frame posts are grooved to the floor and the car is closed at the sides by first drawing down the lower panels from their places under the headlining and then the sashes from the same place. The panels are of sheet copper on the outside and wood veneer on the inside with slats between, giving a flexible sheet which is easily slid down the grooves into place. The sash are in two parts, also carried in grooves, and when drawn down the car is closed. The fitting of the panels and sash is accurate and the appearance of the car is all that can be desired. Long curtains running in grooves separate from the siding and coming down to the floor complete the arrangement.

About $20,000,000 represents the contracts for freight cars placed with the American Car & Foundry Co. since the middle of October. Among the largest orders received and accepted by the company this month were one from the New York Central system for 9,500 freight cars; from the Pennsylvania system, 3,500 freight cars; from the Lehigh Valley, 3,500 freight cars; the Missouri Pacific, 1,300 freight cars; the Norfolk & Western Railroad, 700 cars of various dimensions; the New York & New Haven, 500 cars, and the Delaware & Hudson Co., 300 freight cars. These contracts represent a total of about 17,000 cars, valued at more than $14,000,000. Aside from these, several smaller contracts have been accepted. The above orders are only for the Eastern district. In the West within the last few days the company has received scattering orders for between $2,000,000 and $3,000,000 worth of business in addition.